TAB J
PART 7

US005173840A

United States Patent [19]

Kodai et al.

[11] Patent Number: 5,173,840

[45] Date of Patent: Dec. 22, 1992

[54] **MOLDED IC CARD**

[75] Inventors: **Shojiro Kodai; Katsunori Ochi; Osamu Murakami**, both of Hyogo, all of Japan

[73] Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **691,304**

[22] Filed: **Apr. 25, 1991**

[30] **Foreign Application Priority Data**

May 7, 1990 [JP] Japan 2-117984

[51] **Int. Cl.**[5] **H05K 1/14**

[52] **U.S. Cl.** **361/395**; 361/392; 361/401; 361/399; 364/708; 235/488; 235/492; 257/687

[58] **Field of Search** 361/380, 392, 394, 395, 361/397, 399, 402, 424, 401; 174/52.2; 357/72, 80; 364/708, 900; 235/492, 488, 487, 489

[56] **References Cited**

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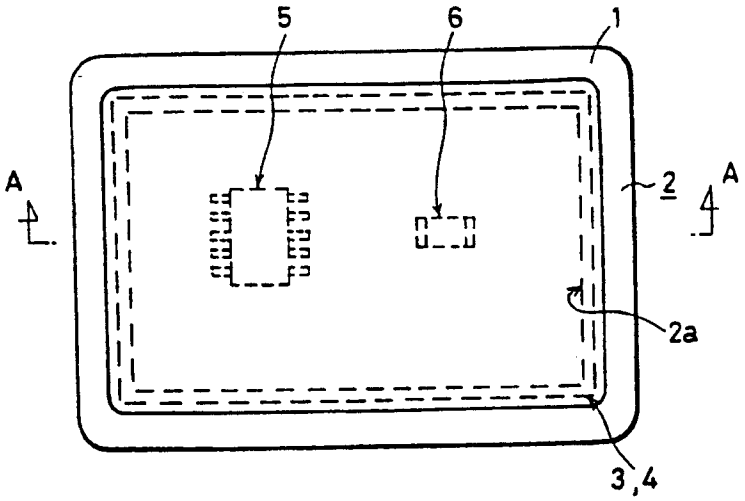
60-217492	10/1985	Japan .

Primary Examiner—Leo P. Picard
Assistant Examiner—Young S. Whang
Attorney, Agent, or Firm—Lowe, Price, LeBlanc & Becker

[57] **ABSTRACT**

An IC card includes a thin plate forming an external surface of the card, a circuit board formed on an internal surface of the thin plate, and a frame surrounding peripheries of the thin plate and the circuit board. A space defined by the frame and the surface plate is filled with molded resin. A portion of an inner peripheral surface of the frame projects into the resin. The molded resin completely covers a surface of the circuit board and integrates the frame and the thin plate.

9 Claims, 6 Drawing Sheets



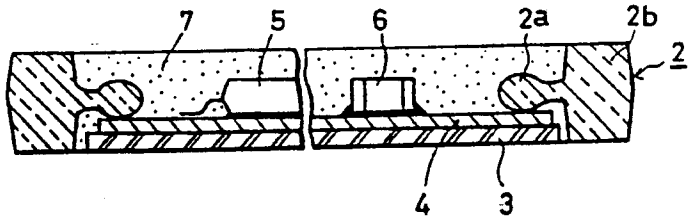


FIG. 1A

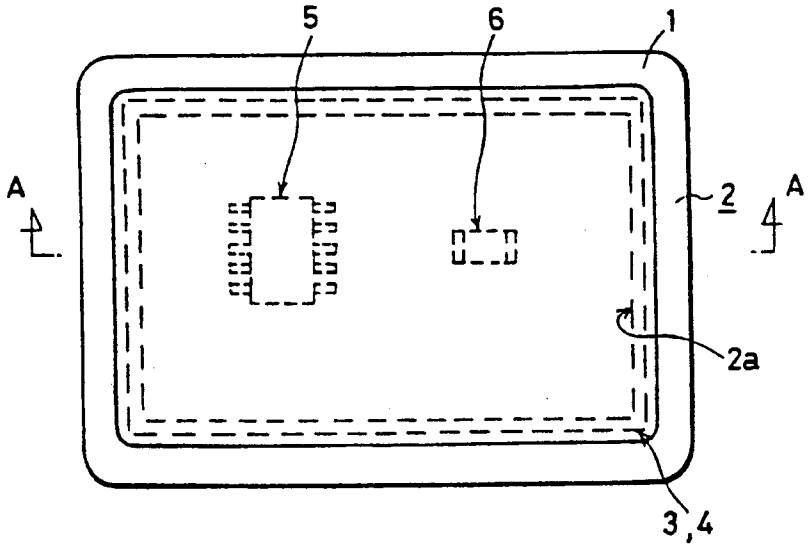


FIG. 1B

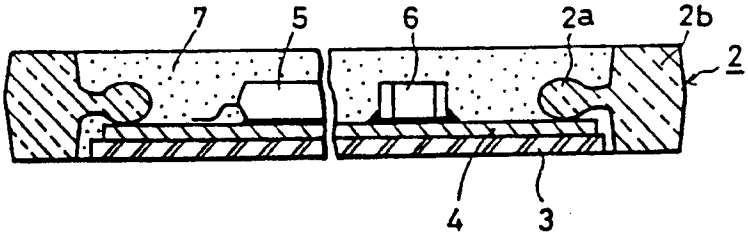


FIG. 2A

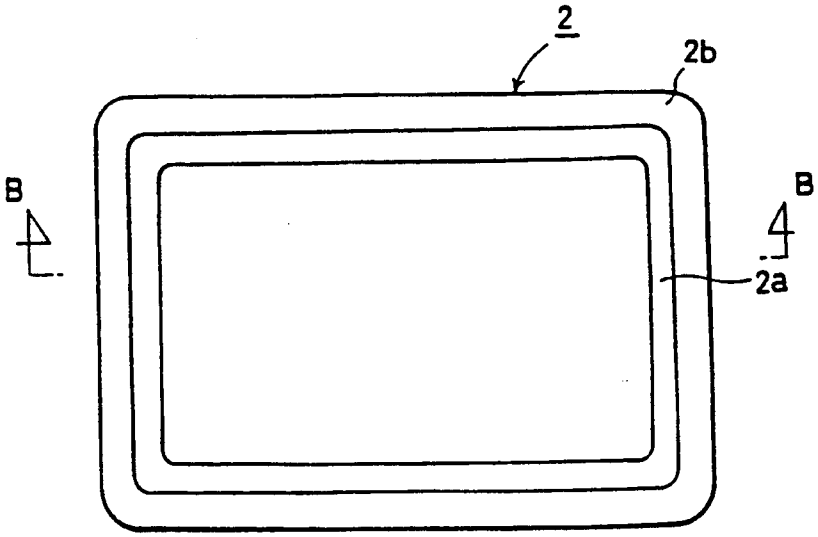


FIG. 2B

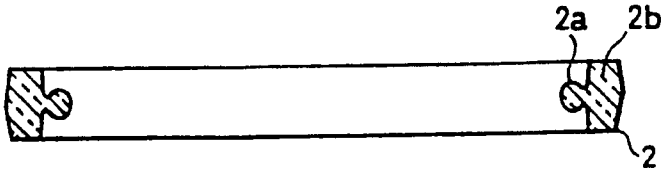


FIG. 2C

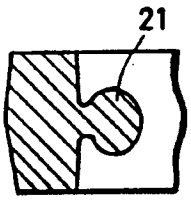


FIG. 2D

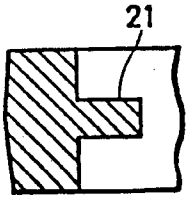


FIG. 3A

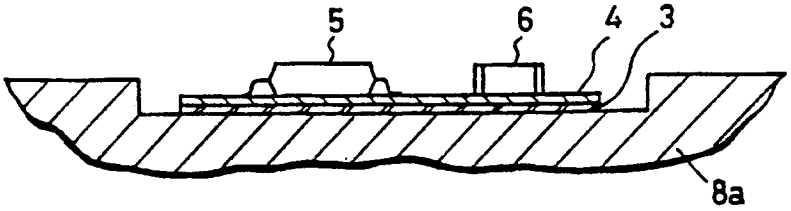


FIG. 3B

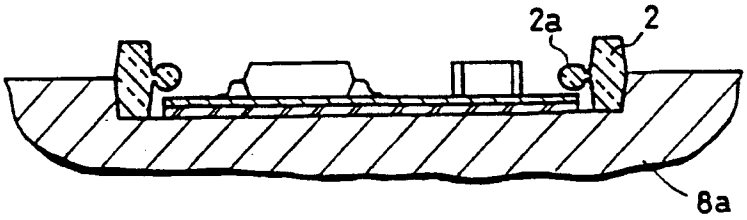


FIG. 3C

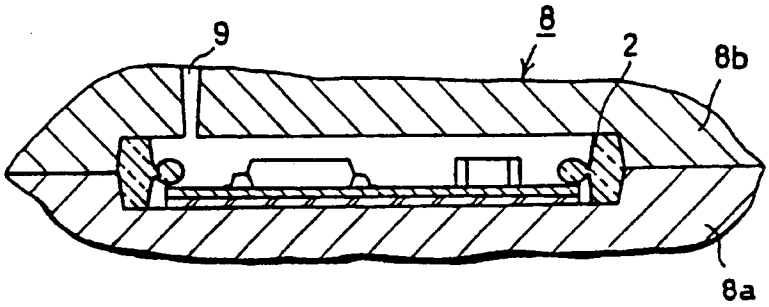


FIG. 3D

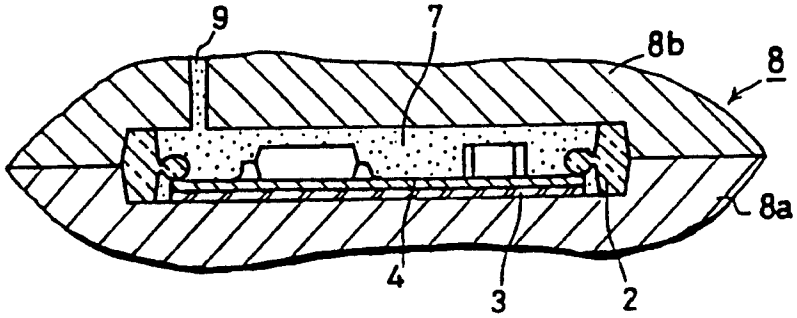


FIG.4

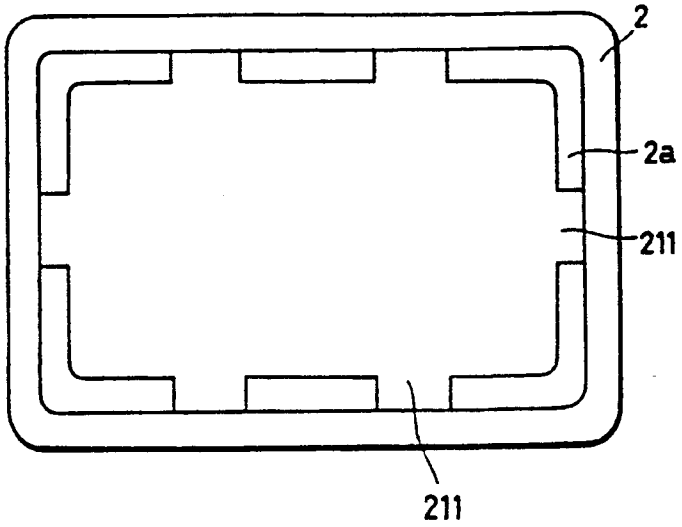


FIG.5

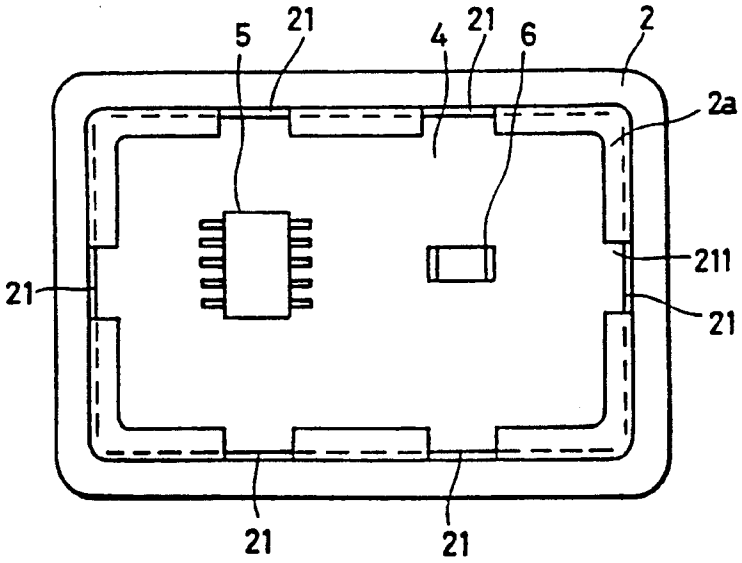


FIG.6

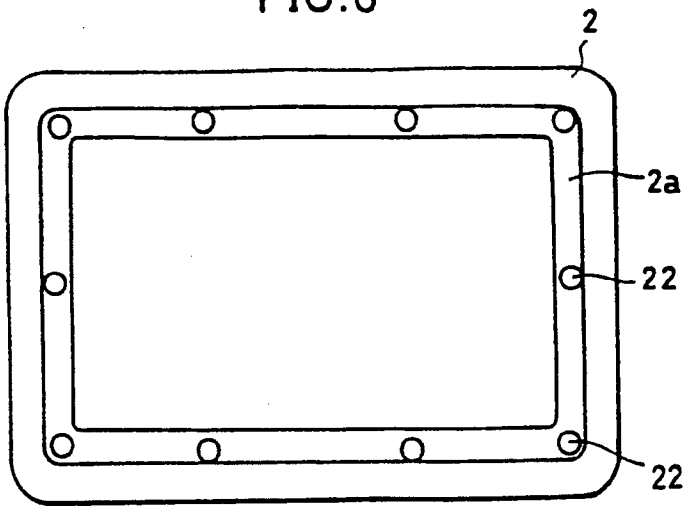


FIG.7

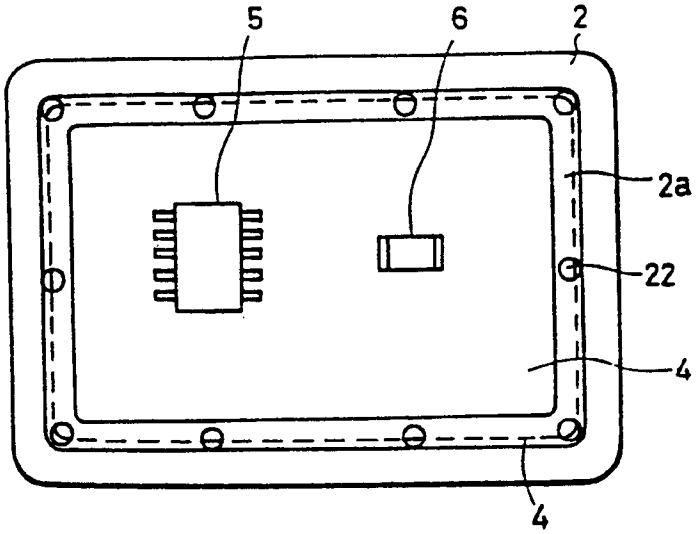


FIG. 8A

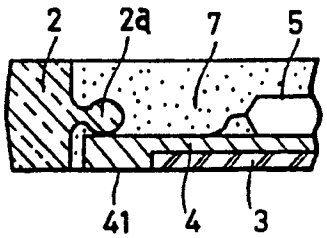


FIG. 8B

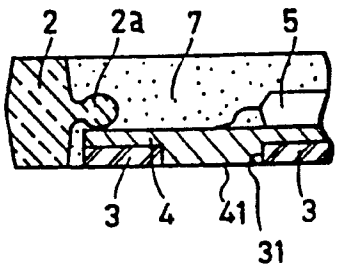


FIG.9A PRIOR ART

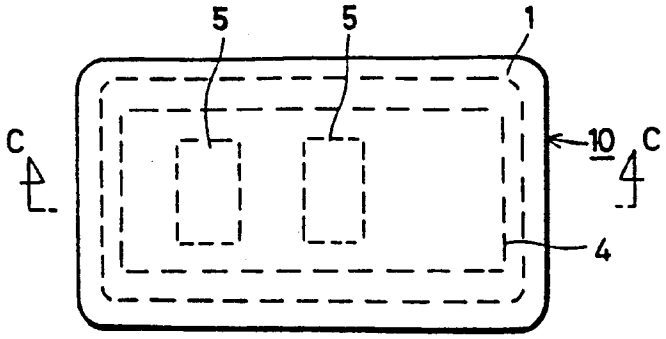


FIG.9B PRIOR ART

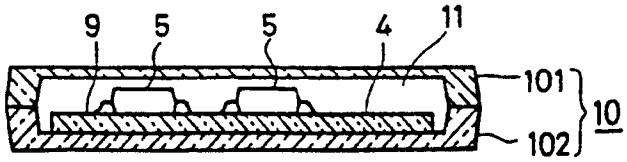


FIG.10A PRIOR ART

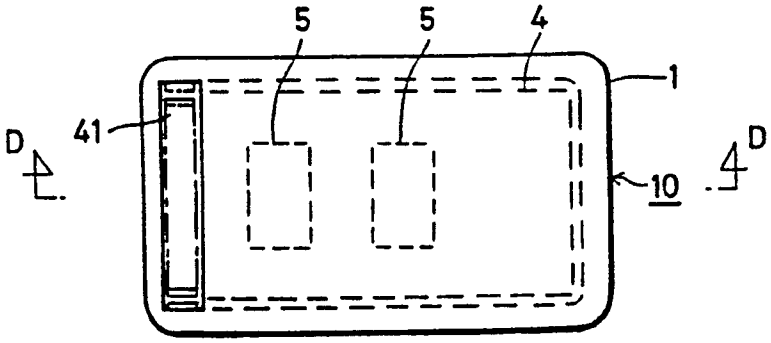
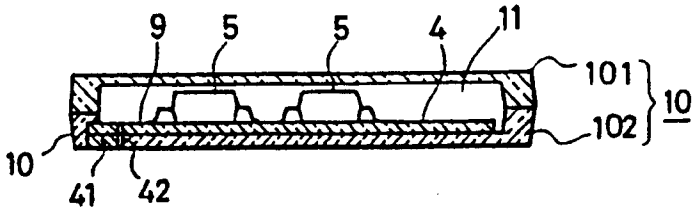


FIG.10B PRIOR ART



MOLDED IC CARD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to structures of an IC card in which a microcomputer and/or an IC memory are embedded in a plate such as a credit-card-sized plate.

2. Description of the Background Art

FIGS. 9A and 9B show a conventional IC card. FIG. 9A is a plan view of the IC card of a non-contact type, and FIG. 9B is a structural cross section taken along line C—C in FIG. 9B.

The IC card has the same size as that of credit cards, and incorporates an integrated circuit(s) such as a microprocessor and/or a memory. The IC card has advantages that a memory capacity is larger than those of a magnetic card or the like, and that information can be altered.

Referring to FIGS. 9A and 9B, an IC card 1 includes a pair of upper and lower casings 101 and 102, and a circuit board 4 assembled in the casings 101 and 102. On a surface of the circuit board 4, there are formed an IC (integrated circuit) device 5 as well as an interconnection pattern 9 connected to the IC device 5. The circuit board 4 is fixed to an internal surface of the lower casing 102. A space is formed between the circuit board 4 and an internal surface of the upper casing 101, and between the board and the internal surface of the lower casing 102.

FIGS. 10A and 10B illustrates a conventional IC card of another type. FIG. 10A is a structural plan view of the IC card of a contact type having an electrode terminal for an external connection, and FIG. 10B is a structural cross section taken along line D—D in FIG. 10A. The IC card of this type includes an electrode terminal 41 formed on a portion of the surface of the lower casing 102. The electrode terminal 41 is electrically connected to the interconnection pattern 9 on the circuit board 4 via a through hole 42.

The IC cards 1 of the non-contact and contact types described above have spaces 11 in casings 10 made from plastics. The space 11 must have the size large enough to prevent contact between the upper casing 101 and the IC device 5 when the card 1 is deformed to a large extent by an external force. Due to this large space 11, the IC card 1 cannot be made thin.

A strength of, particularly, the upper casing 101 depends only on the thickness of the upper casing 101. Therefore, in order to increase the strength of the IC card 1, the upper casing 101 and the lower casing 102 must have large thicknesses, respectively. This further impedes the reduction of thickness of the IC card.

Further, in the prior art IC card, moisture may enter through a gap between the upper and lower casings 101 and 102. Therefore, the prior art IC card has a problem of low environmental resistivity.

Meanwhile, IC cards having resin coating on the integrated circuit boards provided with the IC devices have been known.

U.S. Pat. No. 4,746,392 has disclosed an IC card in which an integrated circuit module is fitted into a portion of a stack of films which forms a card body. This card body is formed of a stacked structure of films without a frame member surrounding peripheries of these films. The card body has a concave portion. An IC module is fitted into this concave portion, and the gap between the IC module and the concave portion is filled with resin. This resin member covers only the periphery of the IC module, and does not serve as a structural member for the card body.

This IC card further employs a film covering a surface of the resin. Therefore, employment of this surface film impedes the reduction of thickness of the IC card. Further, since the card body is formed of the stacked structure of thin films, the card has low strength at its end or edge portions.

SUMMARY OF THE INVENTION

It is an object of the invention to reduce a thickness of an IC card.

It is another object of the invention to improve strength of an IC card.

It is still another object of the invention to provide an IC card having structures which enables easy manufacturing of an IC card.

An IC card according to the invention comprises a surface plate forming one surface of the IC card, and a circuit board attached to an internal surface of this surface plate and incorporating a semiconductor element. Further, the IC card comprises a frame which extends along a whole peripheral edge of the surface plate and surrounds the surface plate and the circuit board. A space defined by the frame and the surface plate is filled with a filler of which surface forms a rear surface of the IC card. A portion of an inner peripheral surface of the frame projects into the filler.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a structural plan view of an IC card of an embodiment of the invention;

FIG. 1B is a structural cross section taken along line A—A in FIG. 1A;

FIG. 2A is a structural plan view of a frame 2 shown in FIG. 1A;

FIG. 2B is a structural cross section taken along line B—B in FIG. 2A;

FIG. 2C is a fragmentary cross section of a frame 2;

FIG. 2D is a fragmentary cross section of a frame, similar to FIG. 2C;

FIGS. 3A–3D are cross sections illustrating manufacturing steps of an IC card shown in FIG. 1B;

FIG. 4 is a top view of a frame 2 used in an IC card of a second embodiment of the invention;

FIG. 5 is a structural top view of an IC card using a frame 2 shown in FIG. 4;

FIG. 6 is a top view of a frame 2 used in an IC card of a third embodiment of the invention;

FIG. 7 is a structural plan view of an IC card using a frame 2 shown in FIG. 6;

FIG. 8A is a structural fragmentary cross section of an IC card for illustrating a modification of IC cards of first to third embodiments;

FIG. 8B is a structural fragmentary cross section similar to FIG. 8A for illustrating another modification of an IC card;

FIG. 9A is a structural plan view of a prior art IC card;

FIG. 9B is a structural cross section taken along line C—C in FIG. 9A;

FIG. 10A is a structural plan view of another prior art IC card; and

FIG. 10B is a structural cross section taken along line D—D in FIG. 10A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An IC card of a first embodiment of the invention is illustrated in FIGS. 1A and 1B. The IC card 1 includes a thin plate 3 made of resin, a circuit board 4 fixed to a surface of the thin plate 3, a frame 2 surrounding whole peripheries of the thin plate 3 and the circuit board 4, and a molded resin 7 filled inside the frame 2. Other surface of the thin plate 3 forms a top surface of the IC card 1. A surface of the molded resin 7 forms a rear or bottom surface of the IC card 1. Further, the frame 2 principally forms side surfaces of the IC card I.

The thin plate 3 is formed of a thin premolded plate of resin. The circuit board 4 is fixed to an internal surface of the thin plate 3. A predetermined circuit pattern is formed on a surface of a circuit board 4. The surface of the circuit board 4 also bears an IC device 5 and a chip part 6 which have functions such as a memory function and an operation function.

Now, structures of the frame 2 will be described with reference to FIGS. 2A–2D. The frame 2 has a rim-like body 2*b* and a rib or inward projection 2*a* projected from an inner peripheral surface of the frame body 2*b*. The rib 2*a* is located at a substantially central position of the body 2*b* of the frame 2 with respect to a direction of the card thickness. The rib 2*a* is in contact with the surface of the circuit board 4 in a finished card. The rib 2*a* is continuously formed along the inner periphery of the frame body 2*b*, and has a section which is preferably of a dumbbell-shape, as shown in FIG. 2C, or of a square shape, as shown in FIG. 2D. Of course, other sectional shapes may be employed.

Returning to FIG. 1B, the molded resin 7 completely fills a space formed between the frame 2, thin plate 3 and circuit board 4. This molded resin 7 has a protection function for protecting circuits formed on the circuit board 4 and a function as a strength member in the IC card. That is, the complete covering of the surface of, the circuit board 4 with the molded resin 7 improves an environmental resistivity such as a water proof. Further, the rigidity of the molded resign 7 itself resists an external force applied to the IC card 1 to restrict the application of the external force onto the circuit board 4. It is preferable to form all of the frame 2, thin plate 3 and molded resin 7 from the same material such as liquid crystal polymer. However, these may be formed of different kinds of resin.

Now, manufacturing method of the IC card shown in FIG. 1B will be described with reference to FIGS. 3A–3D.

First, as shown in FIG. 3A, the thin plate 3 is laid on a lower die 8*a* of a metal mold 8. Further, the circuit board 4 is laid on the surface of the thin plate 3. The circuit board 4 has the predetermined circuit pattern, IC device 5 and chip parts 6 which are formed in advance on the surface thereof.

Then, as shown in FIG. 3B, the frame 2 is fitted into a concave in the lower die 8*a*.

Then, as shown in FIG. 3C, the upper die 8*b* is lowered to close the mold 8. In this condition, the external surface of the frame 2 is in tight contact an internal surface of the mold 8.

Then, as shown in FIG. 3D, liquid resin is introduced into the mold 8 through a gate 9 formed in the upper die 8*b*. The resin is supplied to fill completely the space inside the mold 8. Thereafter, the resin is hardened, and thus the frame 2, thin plate 3, circuit board 4 and molded resin 7 are integrated. The mold 8 is opened to release the IC card 1.

As described above, the IC card 1 is manufactured by the integration of the respective components, i.e., the frame 2, thin plate 3 and circuit board 4 by the molded resin 7. Therefore, neither bonding step nor stacking step is required, which simplifies the manufacturing steps. Further, the rib 2*a* provided in the frame 2 reliably prevents separation of the molded resin 7 and the frame 2 from each other.

Then, a second embodiment of the invention will be described below. Referring to FIG. 4, the frame 2 of the IC card of the second embodiment is provided at its inner peripheral surface with the rib 2*a* which has a plurality of recesses 211. FIG. 5 illustrates the frame 2 and the circuit board 4 assembled therein. The recesses 211 provided in the rib 2*a* form gaps 21 between the frame 2 and the circuit board 4. The gaps 21 serve such that a space between the frame 2 and the thin plate 3 is sufficiently filled with the introduced resin through these gaps 21.

Further, a third embodiment of the invention will be described below. As shown in FIG. 6, the frame 2 of the third embodiment is provided at several portions of the rib 2*a* with through holes 22. FIG. 7 shows the frame 2 and the circuit board 4 assembled therein. The through holes 22 in the rib 2*a* are located substantially at a boundary region between the frame 2 and the circuit board 4. These through holes 22 serve to fill completely the space with the resin, similarly to the recesses 211 shown in FIG. 4.

Then, modifications of the first to third embodiments will be described below. While the above first to third embodiments are described with respect to a so-called non-contact type in which external electrode terminals of the IC cards are not exposed at the external surfaces, these embodiments can be applied to the IC cards of a contact type having exposed external electrode terminals. FIG. 8A illustrates the structures of the IC card, in which the electrode terminal 41 extending from the circuit board 4 is exposed at the surface of the IC card through a space between the frame 2 and the thin plate. FIG. 8B illustrates the IC card having structures in which the thin plate 3 is provided at a predetermined position with an opening 31 through which the external electrode terminal 41 extending from the circuit board 4 is exposed on the card surface.

As described above, the IC card according to the invention is formed of the frame 2, thin plate 3 and circuit board 4 which are integrated by the molded resin 7. The frame 2 improves the strength and shock resistance at the outer peripheral edge of the IC card. The molded resin improves the environmental resistivity such as the water proof for the circuits formed on the circuit substrate. The rib formed at the inner periphery of the frame reliably fixes the frame and the molded resin together. Further, if the same configurations of the frames are employed, production can be performed with the common molds, independent of types of the circuits formed on the circuit board. Therefore, the

manufacturing steps can be simplified, resulting in an improved productivity.

Further, the IC card according to the invention is manufactured by filling the space defined by the frame and the thin plate with the molded resin. Therefore, the thicknesses of the IC cards are determined to be constant by the configurations of the metal mold which encloses the frames. Thereby, the IC cards having a small and uniform thickness can be produced.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

What is claimed is:

1. An IC card comprising:

a surface plate forming one surface of said IC card,

a circuit board attached to an internal surface of said surface plate and incorporating a semiconductor element,

a frame formed to extend along a peripheral edge of said surface plate and to surround said surface plate and said circuit board, and

a filler which fills a space defined by said frame and said surface plate and forms a rear surface of said IC card; and

wherein a portion of an inner peripheral surface of said frame projects into said filler.

2. An IC card according to claim 1, wherein said inward projection is formed continuously along an outer peripheral edge of said circuit substrate.

3. The IC card according to claim 2, wherein said inward projection has a through hole extending from a front side of said IC card to a rear side thereof.

4. The IC card according to claim 1, wherein said inward projection is partially formed along an outer peripheral edge of said circuit board.

5. The IC card according to claim 4, wherein said inward projection has a through hole extending from a front side of said IC card to a rear side thereof.

6. The IC card according to claim 1, wherein said circuit board has a connection terminal penetrating said surface plate and externally exposed.

7. The IC card according to claim 1, wherein said portion of said inner peripheral surface of said frame projecting into said filler is dumbbell-shaped.

8. The IC card comprising:

a circuit board incorporating a semiconductor element,

a frame formed to extend along a peripheral edge of said circuit board and to surround said circuit board, and

a filler which fills a space defined by said frame and forms a surface of said IC card,

wherein a portion of an inner peripheral surface of said frame projects into said filler to prevent separation of the filler and the frame from each other.

9. The IC card according to claim 8, wherein, said portion of said inner peripheral surface of said frame contacts said circuit board.

* * * * *

US005208450A

United States Patent [19]

Uenishi et al.

[11] Patent Number: 5,208,450

[45] Date of Patent: May 4, 1993

[54] **IC CARD AND A METHOD FOR THE MANUFACTURE OF THE SAME**

[75] Inventors: **Mitsuaki Uenishi**, Takatsuki; **Yoshihisa Takase**, Higashiosaka; **Takashi Fujii**, Katano, all of Japan

[73] Assignee: **Matsushita Electric Industrial Co., Ltd.**, Osaka, Japan

[21] Appl. No.: **777,457**

[22] Filed: **Oct. 16, 1991**

Related U.S. Application Data

[63] Continuation of Ser. No. 445,659, Dec. 15, 1989, abandoned.

[30] **Foreign Application Priority Data**

Apr. 20, 1988 [JP] Japan 63-97071
Apr. 20, 1988 [JP] Japan 63-97076
Apr. 21, 1988 [JP] Japan 63-98661
Apr. 19, 1989 [WO] PCT Int'l Appl. ... PCT/JP89/00418

[51] **Int. Cl.**[5] **G06K 19/06**; G06K 19/02
[52] **U.S. Cl.** **235/492**; 235/488
[58] **Field of Search** 235/441, 488, 492

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58-135656 8/1983 Japan .
62-103195 5/1987 Japan .

Primary Examiner—Eugene R. LaRoche
Assistant Examiner—Michael C. Kessell
Attorney, Agent, or Firm—Panitch Schwarze Jacobs & Nadel

[57] **ABSTRACT**

In an IC card of the invention, an IC module (3) is adhered to a first concave (9) of a card base (1) by means of an adhesive (7) and a gap (8) is formed between the outside surface of the IC module (3) and the inside surface of the first concave (9), the gap being wider in the inside upper part and narrower in the inside lower part of the first concave (9), so that the IC chip in the IC module (3) and the card base (1) can be protected from damages caused by bending of the the card base (1).

2 Claims, 8 Drawing Sheets

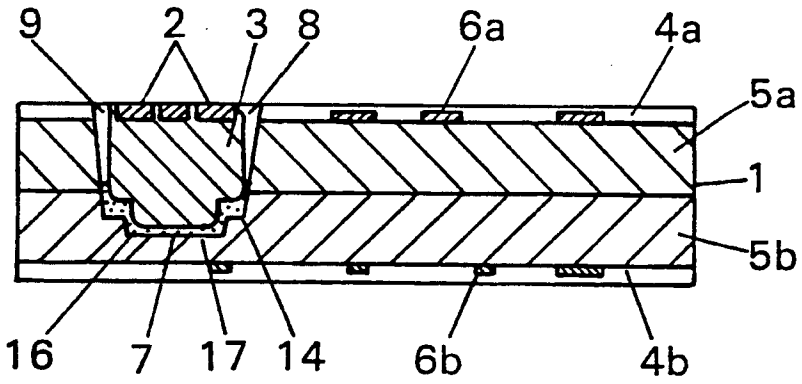


Fig. 1(a)

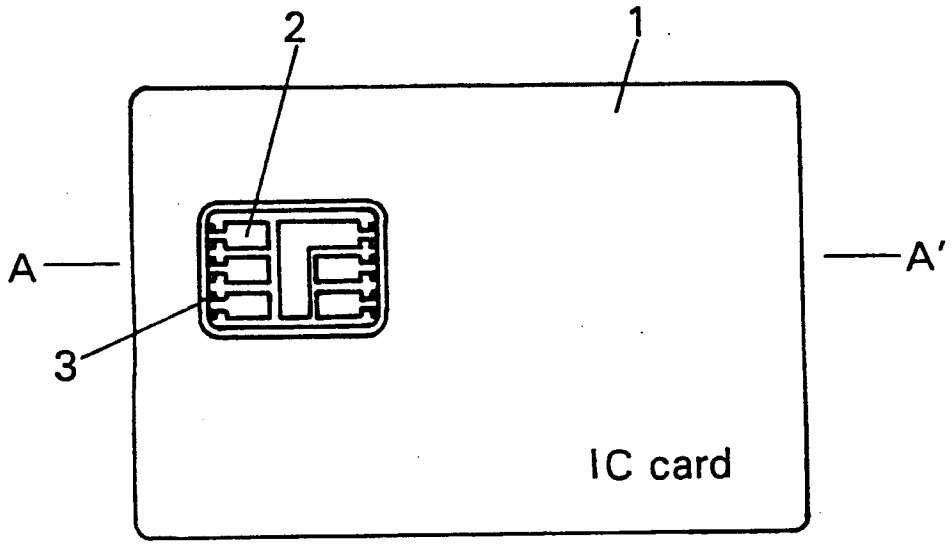


Fig. 1(b)

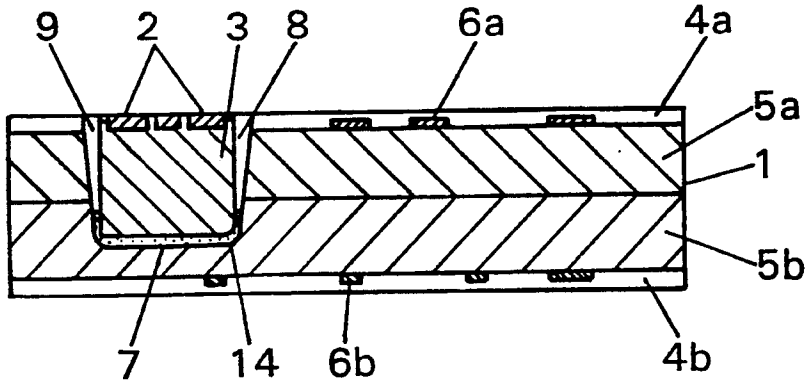


Fig. 2

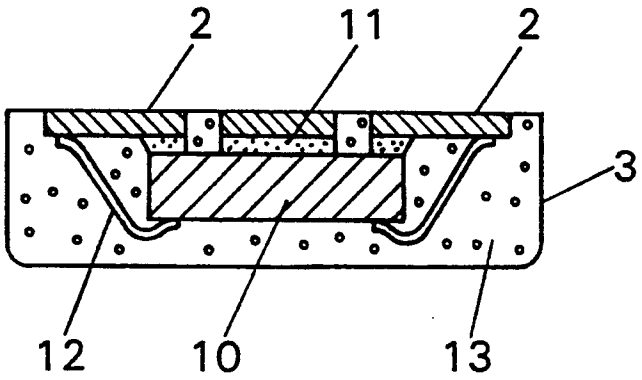


Fig. 3

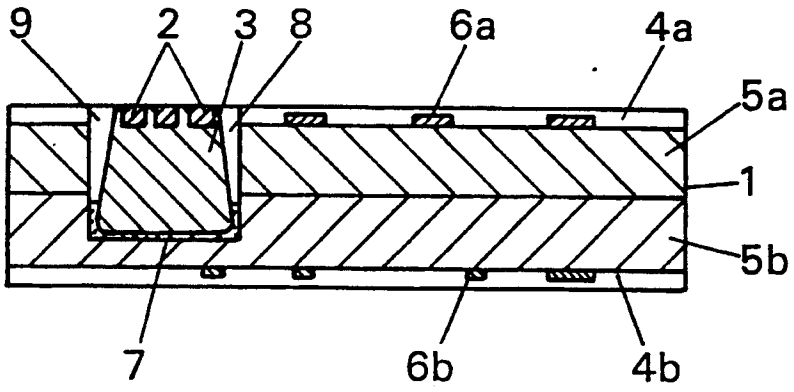


Fig. 4

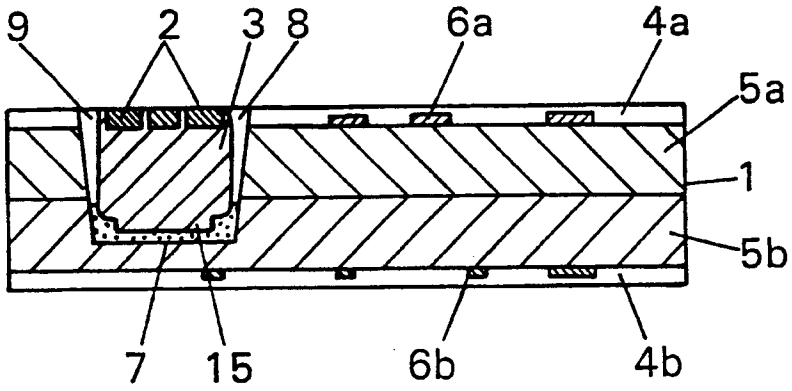


Fig. 5

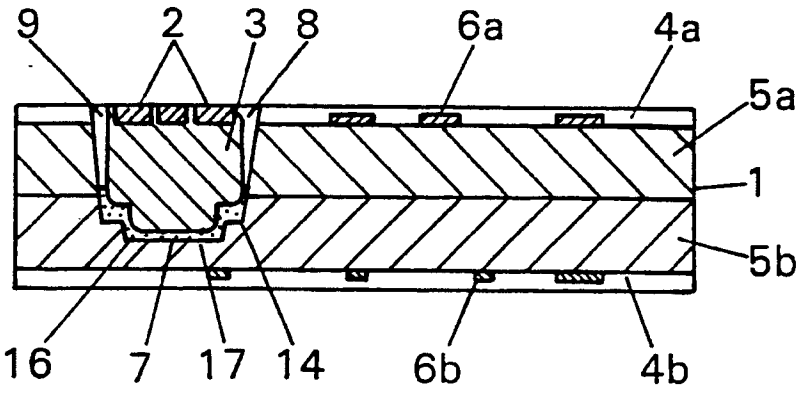


Fig. 6a

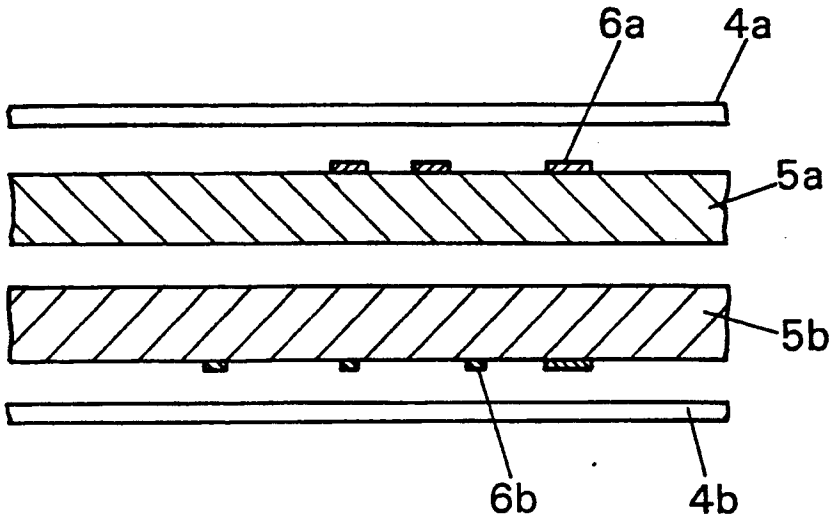


Fig. 6b

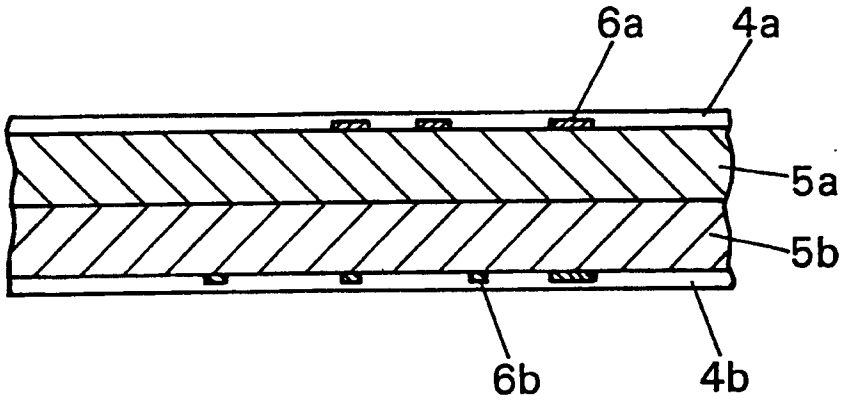


Fig. 7(a)

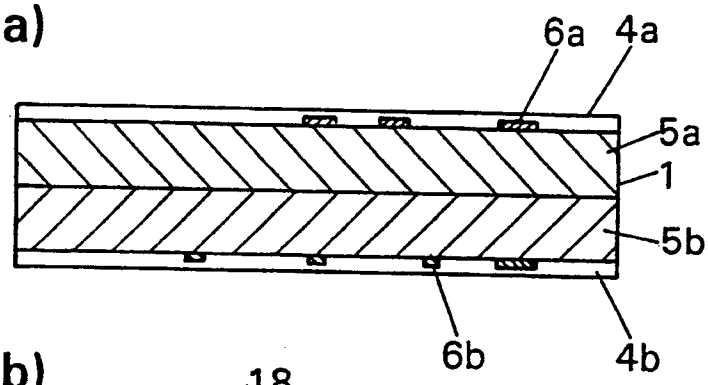


Fig. 7(b)

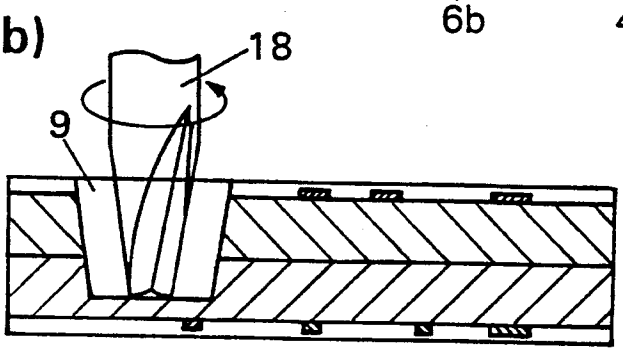


Fig. 7(c)

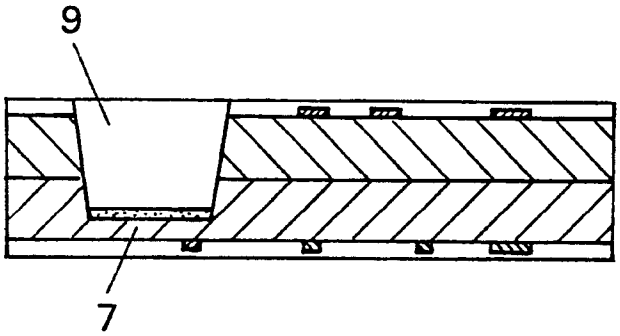


Fig. 7(d)

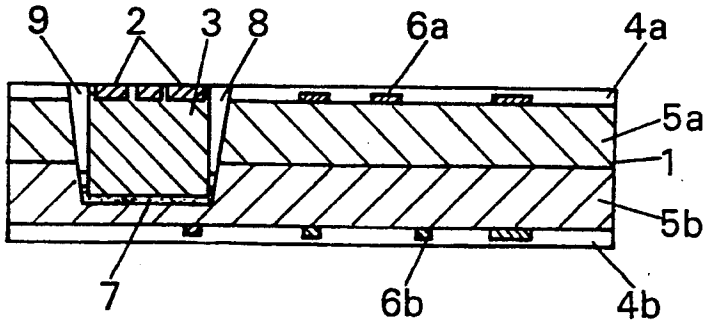
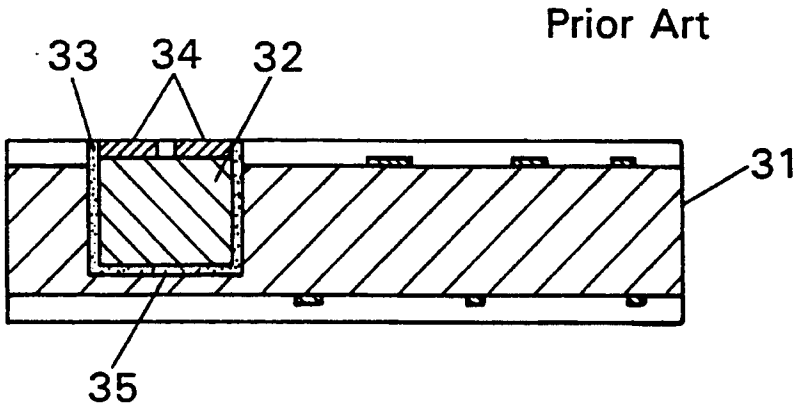


Fig. 8



IC CARD AND A METHOD FOR THE MANUFACTURE OF THE SAME

This application is a continuation of Ser. No. 445,659, filed Dec. 15, 1989, abandoned.

TECHNICAL FIELD

This invention relates to an IC card and a method for manufacturing the IC card, which has an IC module incorporating an IC chip that processes or stores data, can exchange data with external devices, and can be carried and used as a cash card, credit card, identification card or the like.

BACKGROUND ART

A so-called IC card, which incorporates an IC module containing an IC chip having a microcomputer and memories therein and having a series of connection terminals for exchanging data with external devices buried in a card base, is widely known, and its standardization is in process at the ISO (International Organization for Standardization). In comparison with conventional magnetic stripe cards, since such IC cards have a larger memory capacity and are superior in security, practical usages are considered in many fields such as financial businesses, medical institutes and personal identification. The portability of the IC cards are greatly advantageous like that of conventional magnetic stripe cards. Therefore, to put the IC cards into practical use, the reliability must be securely guaranteed in the environment where the IC cards are used, that is, resistance to bending of IC card and protection of the incorporated IC chip from external stresses. Nowadays, this is an important problem.

As a conventional example, a sectional view of an IC card in Japanese Laid-open Patent Publication No. 58-92597 is shown in FIG. **8**. This IC card is constructed by an IC module **32** incorporating an IC chip and having connection terminals **34** with external devices which are adhered inside of a concave **33** formed in a specified position on a card base **31** with an adhesive **35**. An IC card having such a construction is produced by punching out a card base **31** in a desired size, forming a concave **33** with a size similar to an IC module **32** in a desired position, disposing the IC module **32** inside of the concave **33** of the card base **31** by using the adhesive **35** in such a way that the surface of the connection terminals **34** is flush with the surface of the card base **31**.

However, in such conventional IC cards, when the both ends of the card base **31** are bent upward, the inside surface of the concave **33** strongly presses the IC module **32** inward by means of the adhesive **35**, so that the IC chip incorporated in the IC module **32** might be damaged. If the IC chip is protected from the bending stress of IC card by increasing the rigidity of the IC module **32**, even when the IC module **32** is pressed by the inside surface of the concave **33**, because the IC module **32** is rigid, it does not change its form, and reversely, the bending stress of the card base **31** is centralized on the boundary portion between the inside surface and the inside bottom surface of the concave **33**, thereby damaging the card base **31** at the boundary portion.

DISCLOSURE OF THE INVENTION

It is hence a primary object of the invention to present an IC card in which the IC chip in the IC module and the card base are not damaged even when the IC card is bent.

In order to achieve the object, an IC card of the invention comprises a card base, an IC module equipped in the first concave formed in this card base, and an adhesive adhering the IC module onto the inside bottom surface of the first concave, wherein a gap is formed between the inside surface of the first concave and the outside surface of the IC module, said gap being wider at the inner upper part of the first concave and narrower at the inner lower part of the first concave. In such a construction of the IC card, even when the both sides of the card base are bent upward, owing to the presence of a gap between the inside surface of the first concave and the outside surface of the IC module, the inside surface of the first concave does not press the IC module inward. Therefore, the IC chip and the card base itself are not damaged when the card base is bent.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1***a* and *b* are a top view showing an IC card of this invention and a sectional view along line A—A' of FIG. **1***a*, FIG. **2** is a sectional view showing an IC module used in an IC card of the invention, FIGS. **3**, **4** and **5** are sectional views showing other IC cards of the invention, FIGS. **6***a*, *b* and FIGS. **7***a* to d are sectional views showing methods for manufacturing an IC card of the invention, and FIG. **8** is a sectional view showing a conventional IC card.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to the drawings, one of the embodiments of the invention is described in detail below. FIGS. **1** and **2** show one embodiment of the invention. As shown in FIG. **2**, an IC module **3** incorporating an IC chip **10** and having a series of connection terminals **2** to exchange data with external devices is positioned in a first concave **9** that is formed in a specified position of a card base **1** shown in FIG. **1** in such a manner that the surface of each connection terminal **2** is flush with the surface of the card base **1**. The IC module **3** in such a state is adhered to the inside bottom part of the first concave **9** by means of an adhesive **7**. The card base **1** is composed of two center cores **5***a* and **5***b* made of white colored rigid vinyl chloride resin and two over-sheets **4***a* and **4***b* made of transparent vinyl chloride resin that are disposed on the surfaces of the center cores **5***a* and **5***b*, respectively. Between the center core **5***a* and the over-sheet **4***a*, and between the center core **5***b* and the over-sheet **4***b*, although not shown in FIG. **1***a*, desired letters and patterns **6***a* and **6***b* which are visible through the over-sheets **4***a* and **4***b* are formed by a printing technique. The thickness of the center cores **5***a* and **5***b* are both 0.35 mm, that of over-sheets **4***a* and **4***b* are both 0.03 mm, the overall thickness of the card base **1** is 0.76 mm, and the overall dimensions are the same as credit cards. As shown in the sectional view in FIG. **2**, the IC module **3** used in this IC card comprises a connection terminal **2** composed of a metallic thin plate, one surface of which is exposed outside and on the other surface an IC chip **10** that processes or stores data is mounted with an insulating adhesive **11**. The IC chip **10** is connected to the connection terminal **2** by a metallic wire **12**, and

these members are covered with a sealing resin **13** made of an epoxy resin. By the transfer molding method, the IC chip **10** and the peripheral members (adhesive **11**, metallic wire **12**, sealing resin **13** and connection terminal **2**) are molded into one body. The overall dimensions of this IC module **3** are 10.2×12.4 mm, and the thickness is 0.59 mm. The IC chip **10** works by connecting five out of six connection terminals **2**, which are exposed on the surface of the IC module **3** as shown in FIG. **1***a*, to an external device.

As shown in FIG. **1***b*, the inside surface of the first concave **9** formed in the card base **1** continuously inclines inward toward the inside bottom surface of this first concave **9**, and between the inside surface of the first concave **9** and the outside surface of the IC module **3** adhered to the inside bottom surface of the first concave **9**, there is formed an inclined gap **8** which is wider at the inner upper part of the first concave **9** and narrower at the inner lower part of the first concave **9**. In an IC card having such a construction, in the case that the both sides of the card base **1** are bent downward, the gap **8** between the inside surface of the first concave **9** and the outside surface of the IC module **3** simply opens and the inside surface of the first concave **9** does not press the outside surface of the IC module **3** inward, so that a bending stress does not work on the IC module **3**. Reversely, in the case that the both sides of the card base **1** are bent upward, the inside surface of the first concave **9** changes positions more at the inner upper part of the first concave **9** and less at the inner lower part thereof, centering around the boundary portion **14** of the said inside surface and the said inside bottom surface, and comes very close to the outside surface of the IC module **3**. Since the inclined gap **8** which is wider at the inner upper part of the first concave **9** and narrower at the inner lower part is formed between the inside surface of the first concave **9** and the outside surface of the IC module **3**, so long as the card base **1** is exceedingly bent, the inside surface of the first concave **9** and the outside surface of the IC module **3** do not directly contact. Therefore, a bending stress of the card base **1** does not work on the IC module **3**. In a portion of the card base **1** that is close to the boundary portion **14** of the inside surface and the inside bottom surface of the first concave **9**, a tension or a bending stress which may be created in the case that the inside surface of the inner upper part of the first concave **9** and the outside surface of the IC module **3** contact each other is not generated. Thus, even if both sides of the card base **1** are bent either upward or downward, the IC module **3** and the card base **1** are protected from the bending stress.

As a result of our various experiments, it is proved that by forming the inside surface of the first concave **9** at an inclination of 10 deg., against the perpendicular and setting the internal angle between the inside surface of the first concave **9** and the outside surface of the IC module **3** at 10 deg., the IC module **3** and the card base **1** are protected at a practical level against a bending of the IC card. The inner dimensions of the inside bottom surface of the first concave **9** are set at 10.28×12.48 mm, taking the allowance of the inner dimensions and the allowance of the outer dimensions of the IC module **3** in consideration, and the depth of the first concave **9** is set so that the thickness of the remaining part of the card base **1** at the lower inside bottom surface of the first concave **9** becomes 0.15 mm. The thickness of the remaining part of the card base **1**, 0.15 mm, is composed of a thickness 0.03 mm of the over-sheet **4***b* and the remaining thickness 0.12 mm of the center core **5***b*, and this composition is an important factor that determines durability and strength of the card base **1** against bending, as the thickness of the card base **1** is the smallest.

Then, as comparison examples, IC cards were produced by setting the remaining thickness 0.15 mm of the card base **1** to be constant and changing the thickness of the over-sheet **4***b* from 0.03 mm of the embodiment to 0.05 mm and 0.08 mm. The results of examining the durability of the IC cards against bending are shown in Table 1 below. The bending test was performed by bending the shorter edges of the IC cards downward with an amplitude of 10 mm at a speed of 30 times per minute, and the number of times of bending until a crack occurred in the card base **1** at the lower inside bottom surface of the first concave **9** were evaluated.

TABLE 1

Evaluation items	Thickness of over-sheet 0.03 mm	0.05 mm	0.08 mm
Average value	1310	799	622
Standard deviation	244	91	171

As shown in Table 1, an IC card of the embodiment with the over-sheet **4***b* of 0.03 mm in thickness has the largest bending durability. In addition, the transparent over-sheets **4***a* and **4***b* of 0.03 mm are useful in that the letters and patterns **6***a* and **6***b* are clearly visible therethrough. The use of the over-sheets **4***a* and **4***b* with a thickness of less than 0.03 mm is not desired because they do not protect the letters and patterns **6***a* and **6***b* and they are inferior in handling. As the adhesive **7** that adheres the bottom surface of the IC module **3** to the inside bottom surface of the first concave **9**, a silicone resin adhesive, the main ingredient of which is a denaturated polymer of silicone having a rubbery elasticity even after it is hardened, was used. As the denaturated polymer of silicone, for example, a silicone resin denaturated by the addition of an epoxy resin with elasticity was used, the epoxy resin being obtained by the addition of an amine adduct of polypropylene glycol glycidyl ether to a bisphenol epoxy resin. As comparison examples, IC cards were produced by using, instead of the adhesive **7** with a rubbery elasticity, an epoxy resin adhesive containing denaturated polyamine hardener and an acrylic resin adhesive as adhesives having some flexibility but not rubbery elasticity after hardening, and the mechanical characteristics (bending characteristics, twisting characteristics, shock-resistance) of the IC cards were evaluated. The evaluation results are shown in Table 2. In Table 3, the results of environmental experiment of IC cards of this embodiment are shown. The IC cards of the embodiment have no problem with mechanical strength, chemical resistance, humidity resistance and water resistance, and have a sufficient reliability.

TABLE 2

Adhesive	Embodiment Silicone resin with a denaturated polymer of silicone as its main ingredient	Comparative example Epoxy resin	Comparative example Acrylic resin
Bending characteristics *1)	2300 times or more	250 times or more	300 times or more
Twisting characteristics *2)	OK	NG	NG
Shock-	○	X	X

TABLE 2-continued

Adhesive	Embodiment Silicone resin with a denaturated polymer of silicone as its main ingredient	Comparative example Epoxy resin	Comparative example Acrylic resin
resistance			

*1) Bending characteristics; experimented by bending the cards in the shorter direction and the longer direction on both faces of the cards, top and bottom, and right and left.
Longer direction; flexibility (f): 20 mm, periodicity; bending for 30 times/min
Shorter direction: flexibility (f): 10 mm, periodicity; bending for 30 times/min
Neither the function of a card is lost after the bending test nor remarkable cracks arise.
*2) Twisting characteristics; When the IC card is twisted with ±15 deg., 30 times/-min and 1,000 times, around the axis in the longitudinal direction, the IC module is not peeled off, remarkable cracks do not arise and IC performance is still normal.

surface of the first concave **9** and the outside surface of the IC module **3**. A convex **15** is formed in the middle of the bottom surface of the IC module **3**, and the bottom surface of the IC module **3** and the inside bottom surface of the first concave **9** are adhered by means of an adhesive **7** having a rubbery elasticity even after hardening. The thickness of the adhesive **7** on the bottom surface of the IC module **3** is larger at the peripheral part than the center part where the convex **15** is formed. It is effective to increase the thickness of the adhesive **7** in order to prevent the IC module **3** from peeling off from the first concave **9** in the case that both sides of the base **1** are bent downward. The adherence itself increases as well as its expandability with an increase in the thickness of the adhesive **7**, so that the IC module **3**

TABLE 3

Item	Sodium carbonate 1% 24 Hr	Brine 5% 24 Hr	Acetic acid 5% 24 Hr	Alcohol 100% 24 Hr	Hot water 60° C. 1 Hr	Humidity resistance 74 Hr	Heat-shock 24 c/s	Dropping 1.5 m
Embodiment	○	○	○	○	○	○	○	○

In the IC card of the embodiment, since the adhesive **7** has a rubbery elasticity even after hardening, outside stress and shock are weakened by this adhesive **7**, and thus, even when bending, twists and shocks are applied to the card base **1**, the IC module **3** was not peeled off from the first concave **9**, neither cracks occurred in the card base **1** nor abnormal operating performance of the IC chip **10** was caused. In the IC card of the embodiment, it is considered that a small amount of the adhesive **7** between the bottom surface of the IC module **3** and the inside bottom surface of the first concave **9** invades into the gap **8** between the outside surface of the IC module **3** and the inside surface of the first concave **9**, but as shown in Table 2, the phenomenon has no effect on the mechanical characteristics of the IC card.

FIGS. **3** to **5** show sectional views of other embodiments of the invention. In the embodiment of FIG. **3**, the outside surface of the IC module **3** is inclined outward toward a lower portion, so that an inclined gap **8** which is wider at the inside upper part of the first concave **9** and narrower at the inside lower part is formed between the inside surface of the first concave **9** and the outside surface of the IC module **3**. The bottom surface of the IC module **3** is adhered to the inside bottom surface of the first concave **9** by means of an adhesive having a rubbery elasticity even after hardening. It is evident from the embodiment of FIG. **1** that the IC module **3** and the card base **1** of the inside bottom surface of the first concave **9** are protected from bending stresses even when the card base **1** is bent upward or downward. Of course, when the outside surface of the IC module **3** is made wide outward toward a lower portion thereof and the inside surface of the first concave **9** is inclined inward toward the bottom surface of the first concave **9**, a linearly inclined gap **8** which is wider at the inside upper part of the first concave **9** and narrower at the inside lower part is formed between the inside surface of the first concave **9** and the outside surface of the IC module **3**, and thus, the reliability of the IC card against bending stress is further improved.

In the embodiment of FIG. **4**, an inclination is constructed inward in the direction of the inside bottom surface of the first concave on the inside surface of the first concave **9**, and an inclined gap **8** which is wider at the inside upper part and narrower at the inside lower part of the first concave **9** is formed between the inside can be stably held inside of the first concave **9**. It is more important to increase the thickness of the adhesive **7** at the peripheral part than at the center part of the bottom surface of the IC module **3** in order that the IC module **3** is stably held inside of the concave without peeling off in the initial stage. In the embodiment of FIG. **4**, the height of the convex **15** on the bottom surface of the IC module **3** is set at 0.02 mm, and the thickness of the adhesive **7** is formed to be 0.02 mm in the center part of the bottom surface of the IC module **3** and 0.04 mm in the peripheral part. In order to increase the thickness of the adhesive **7**, it is required to decrease the thickness of the IC module **3** or the thickness of the remaining portion of the card base **1** that faces the inside bottom surface of the first concave **9**, but it deteriorates the mechanical strength of the IC module **3** or the card base **1**. However, in the IC card shown in the embodiment of FIG. **4**, it is possible to increase the thickness of the adhesive **7** without decreasing the thickness of the center part of the IC module **3** in which the IC chip is incorporated, and it enables to improve the initial exfoliation strength between the IC module **3** and the card base **1** without deteriorating the rigidity of the IC module **3**. Moreover, even if the thickness of the adhesive **7** between the convex **15** on the bottom surface of the IC module **3** and the inside bottom surface of the first concave **9** is reduced, the thickness of the adhesive **7** between the peripheral part of the bottom surface of the IC module **3** and the inside bottom surface of the first concave **9** can be obtained so that the IC module **3** is stably held inside of the first concave **9**, which creates no problem.

In the embodiment of FIG. **5**, a first concave **9** is formed at a specified position in the card base **1**, and a second concave **16** is formed in the inside bottom surface of the first concave **9**. The inside surfaces of both the first concave **9** and the second concave **16** are inclined inward toward the inside bottom surfaces of the first concave **9** and the second concave **16**, respectively. Therefore, between the inside surfaces of the first concave **9** and the outside surface of the IC module **3** and between the second concave **16** and the convex **17** of the IC module that is positioned in the second concave **16**, an inclined gap **8** which is wider in the inside upper part and narrower in the inside lower part of each of the first concave **9** and the second concave **16** is formed. In

the center part of the bottom surface of the IC module **3**, a convex **17** that is positioned in the second concave **16** is formed, and the bottom surface of the IC module **3** is adhered to the inside bottom surfaces of the first concave **9** and the second concave **16** by means of an adhesive **7** having a rubbery elasticity even after hardening. The height of the convex **17** on the bottom surface of the IC module **3** is 0.1 mm, the thickness of the remaining portion of the card base **1** that faces the lower inside bottom surface of the first concave **9** is 0.25 mm, the thickness of the remaining portion of the card base **1** that faces the lower inside bottom surface of the second concave **16** is 0.15 mm, the thickness of the adhesive **7** between the inside bottom surface of the first concave **9** and the bottom surface of the IC module **3** is 0.02 mm, and the thickness of the adhesive **7** between the inside bottom surface of the second concave **16** and the convex **17** is 0.02 mm. In this construction, since the card base **1** is bent around the boundary portion **14** between the inside surface of the first concave **9** and the inside bottom surface of the first concave **9**, even in the case that the inside surface of the first concave **9** is not brought into contact with the outside surface of the IC module **3**, a bending stress is generated on a portion of the card base **1** in the vicinity of the boundary portion **14**. However, in the IC card of the embodiment of FIG. **5**, because the thickness of the remaining portion of the card base **1** in the vicinity of the boundary portion **14** can be made larger than that of the embodiment of FIG. **3** and the area of the inside bottom surface of the second concave **16** can be decreased as much as possible where the thickness of the card base is the smallest, the mechanical strength and the durability of the card base **1** against the bending stress can be improved. This effect is especially effective when the both sides of the IC card are bent downward. With an IC card having both IC module **3** and magnetic stripes, data in the magnetic stripes can be read by inserting the IC card into a reading device such as ATM. Rollers for conveying a cash card of an existing ATM drive in the center part of the cash card, and in the IC card approved by ISO, the rollers driving the IC card run over the IC module **3**. Therefore, a large load is generated especially in the peripheral part of the IC module **3**, and the card base **1** of the bottom part of the IC module **3** might be damaged. However, when an IC card such as that of the embodiment of FIG. **5** is formed, the thickness of the card base **1** can be made larger in the peripheral part of the bottom surface of the IC module **3** and it withstands the load of the rollers for driving IC cards. That is, the IC card is superior in durability.

Moreover, since the convex **17** in the center part of the IC module **3** occupies a major part of the bottom surface of the IC module **3**, even though the thickness of the peripheral part of the IC module **3** is reduced to some extent, the rigidity of the IC module **3** does not deteriorate and the IC chip incorporated in the IC module **3** is not damaged by the above-mentioned load.

The foregoing embodiments disclose the IC cards having an inclined gap **8** between the inside surface of the first concave **9** and the outside surface of the IC module **3**, wherein the distance between the inside surface of the first concave **9** and the outside surface of the IC module **3** linearly narrows from the inside upper part toward the inside lower part of the first concave **9**.

However, the IC cards of the invention are not limited to these embodiments. As far as a gap **8** which is wider in the outside upper part and narrower in the inside lower part of the first concave **9** exists between the inside surface of the first concave **9** and the outside surface of the IC module **3**, in the middle part positioned between the inside upper part of the first concave **9** and the inside lower part of the first concave **9**, the gap **8** between the inside surface of the first concave **9** and the outside surface of the IC module **3** can be formed in any shape such as a curve or steps.

Next, a manufacturing method of IC cards of the invention is described by mainly explaining the IC card of the embodiment in FIG. **1**, referring to sectional views of the IC card shown in FIGS. **6** and **7**.

As a large sheet card material from which plural IC cards can be obtained, over-sheets **4***a* and **4***b* of 0.03 mm in thickness made of a transparent vinyl chloride resin and center cores **5***a* and **5***b* of 0.35 mm in thickness made of a white opaque rigid vinyl chloride resin are prepared. On the surfaces of the center cores **5***a* and **5***b*, logos, design letters and patterns **6***a* and **6***b* necessary for an IC card are formed with a thickness of 0.02 mm or less by a screen printing or offset printing technique (FIG. **6***a*). Next, the over-sheet **4***b* and the over-sheet **4***a* are placed on the top and in the bottom, respectively, and between these over-sheets **4***a* and **4***b*, the center cores **5***a* and **5***b* are stacked so that the letters and patterns **6***a* and **6***b* face to the over-sheets **4***a* and **4***b*, respectively, after which they are put between mirror-finished stainless steel plates, and heated to 100° C.–150° C. and cooled while applying a pressure of 15 to 35 Kg/cm^2 for several tens of minutes to obtain a large laminate of 0.76 mm in thickness (FIG. **6***b*). By cutting this laminate to separate it into individual IC cards and removing those having damage in the letters and patterns **6***a* and **6***b* or cards themselves, a card base **1** used for an IC card of the invention can be obtained (FIG. **7***a*). A protective layer of the over-sheets **4***a* and **4***b* of 0.01 mm or more in thickness is formed over the letters and patterns **6***a* and **6***b*, and a gap between the letters and patterns **6***a* and **6***b* and the center cores **5***a* and **5***b* are buried by the over-sheets **4***a* and **4***b*, thus the surface of the card base **1** is finished flat. Next, by using a numerically controlling drilling device equipped with a drill **18**, a cutting treatment is executed to form the first concave **9** in a specified position of the card base **1** into which the IC module **3** is inserted (FIG. **7***b*). In the leading part and the peripheral part of the drill **18**, a linear cemented carbide tip is disposed, and in the peripheral part, an inclination is formed so that the diameter of the drill **18** becomes smaller from the upper part to the leading part of the drill **18**, which has an inclination of 10 deg., against the perpendicular. By driving the drill **18** at a high speed, lowering it to a specified depth from the surface of the card base **1**, and then, relatively moving the drill **18** and the card base **1** in a horizontal direction in accordance with the shape of the first concave **9**, the first concave **9** is formed. On the inside surface of the first concave **9**, the inclination of the drill **18** is transcribed and an inclination of 10 deg. is formed inward toward the inside bottom surface of the first concave **9**. In the case that the second concave **16** in the card base **1**, such as that of the IC card of the embodiment of FIG. **5** is formed, the drill **18** is lowered again to a specified depth and the drill **18** and the card base **1** are relatively moved in a horizontal direction in accordance with the shape of the second concave **16**. The outer dimensions of the inside bottom surface of the first concave **9** is 10.28×12.48 mm, the depth of the first concave **9** is 0.61 mm and the thickness of the remaining portion of the card base **1**

that faces the first concave **9** is 0.15 mm. Thereafter, by using a dispenser, a few milligrams of the adhesive **7** that has a denaturated polymer of silicone as its main ingredient and that has a rubbery elasticity even after hardening is dropped on the inside bottom surface of the first concave **9** (FIG. 7*c*). The IC module **3** is molded by the transferring molding method with an outer size of 10.2×12.4 mm and a thickness of 0.59 mm, connection terminals **2**, an IC chip **10** and metallic wires **11** being incorporated into the IC module in one body as shown in FIG. **2**. In IC cards of the embodiments of FIGS. **4** and **5**, the convexes **15** and **17** of the bottom surface of the IC module **3** are formed by conforming the inner shape of a mold used for the transferring molding method to the shapes of the convexes **15** and **17**.

Then, the IC module **3** is inserted into the first concave **9** so that the connection terminal **2** exposes in the surface of the card base **1**, and by using a pressing device, the surface of the IC module **3** is pressed for 30 to 40 sec., under a pressure of 3.8 to 6.2 g/mm^2.

The IC module **3** is smoothly inserted into the first concave **9** along the inclination constructed in the inside surface of the first concave **9**, and in the inside lower part of the first concave **9**, the gap **8** between the inside surface of the first concave **9** and the outside surface of the IC module **3** is narrow, so that the IC module **3** hardly moves inside of the first concave **9**. Therefore, by simply dropping the IC module **3** into the first concave **9**, the IC module **3** is precisely positioned in a specified position of the card base **1** without using a special device. Then the pressing is discontinued, the IC card is inserted in a magazine and heated for 40 to 70 mins., at a temperature of 45° to 55° C. to primarily harden the adhesive **7**, and then successively leaving the card for 48 hours at room temperature, the adhesive **7** is secondarily hardened.

The thickness of the adhesive **7** is formed in 0.02 mm after it is completely hardened, and the thickness of the IC card becomes 0.76 mm.

In such a way, an IC card of the invention, in which a linearly inclined gap **8** which is wider in the inside upper part and narrower in the inside lower part of the first concave **9** is formed between the inside surface of the first concave **9** and the outside surface of the IC module **3**, is obtained (FIG. 7*d*). By this manufacturing method, the adhesive **7** is hardened at a temperature lower than the thermal deformation temperature of the card base **1** and only a very small pressure is applied to the IC module **3**, so that any change in shape of the card base **1** or damage in the IC module **3** does not occur.

Industrial Applicability

As mentioned above, according to this invention, a gap which is wider in the inside upper part and narrower in the inside lower part of the first concave is formed between the inside surface of the first concave formed in the card base and the outside surface of the IC module constructed in the first concave, and even when the card base is bent, the inside surface of the first concave does not strongly press the outside surface of the IC module inward.

Therefore, the IC chip in the IC module and the card base itself are hardly damaged.

We claim:

1. An IC card comprising a flexible card base, an IC module constructed in a first recess formed in the card base and an adhesive adhering the IC module to the inside bottom surface of the first recess, the adhesive having sufficient elasticity to absorb stress caused by bending of the card base, the adhesive maintaining said elasticity after hardening, wherein a gap is formed between the inside surface of the first recess and the outside surface of the IC module, the difference between the inside surface of the first recess and the outside surface of the IC module gradually becoming narrower from the inside upper part of the first recess toward the inside lower part of the first recess, wherein a second recess is formed in the inside bottom surface of the first recess excluding a peripheral portion thereof, and a protrusion protruding toward the second recess is formed on the bottom surface of the IC module.

2. An IC card according to claim **1**, wherein an adhesive containing a denaturated polymer of silicone as a main ingredient is used as an adhesive.

* * * * *

US005250341A

United States Patent [19]

Kobayashi et al.

[11] **Patent Number: 5,250,341**

[45] **Date of Patent: Oct. 5, 1993**

[54] **IC CARD**

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[73] Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **648,511**

[22] Filed: **Jan. 30, 1991**

[30] **Foreign Application Priority Data**

Mar. 26, 1990 [JP] Japan 2-78295

[51] **Int. Cl.**[5] **B32B 3/00**

[52] **U.S. Cl.** **428/137**; 428/209; 428/915; 428/916; 428/198; 283/77; 283/83; 283/107; 283/109

[58] **Field of Search** 428/137, 209, 915, 916, 428/198; 283/77, 83, 107, 109

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Primary Examiner—Patrick J. Ryan
Assistant Examiner—Cathy Lee
Attorney, Agent, or Firm—Leydig, Voit & Mayer

[57] **ABSTRACT**

In an IC card and a manufacturing method therefor, an adhesive is applied between core layers in the vicinity of an opening in which an IC module is placed. The core sheet layers held between adhesive layers can easily be deformed when heat and pressure are applied. Therefore, a gap formed between the card substrate and the IC module is filled. Furthermore, the gap from the IC module is narrower at the corners of the IC module than conventionally shaped openings. As a result, gaps at the corners of the IC module after integral molding are prevented. Therefore, the gap between the IC module and the card substrate can be reliably filled during molding.

16 Claims, 8 Drawing Sheets

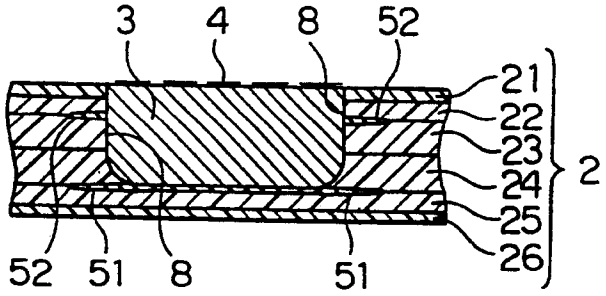


FIG. IA

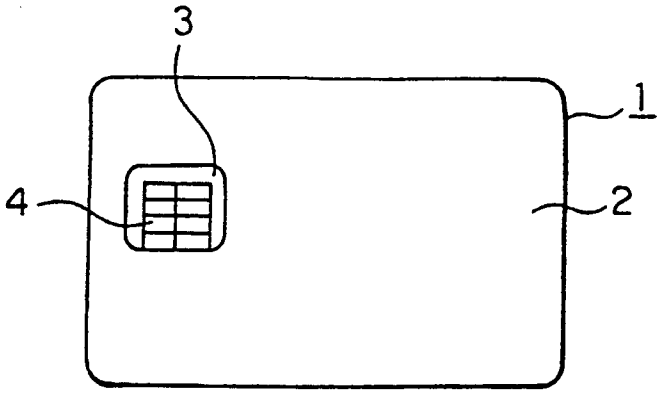


FIG. IB

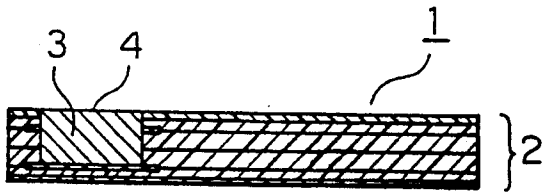


FIG. IC

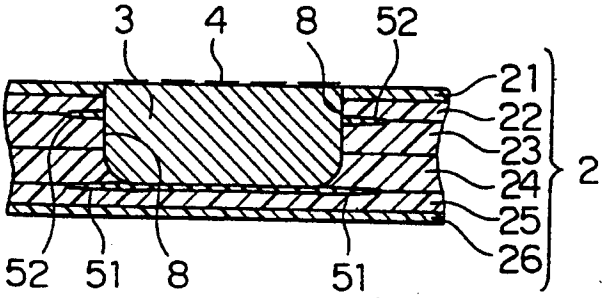


FIG. 2B

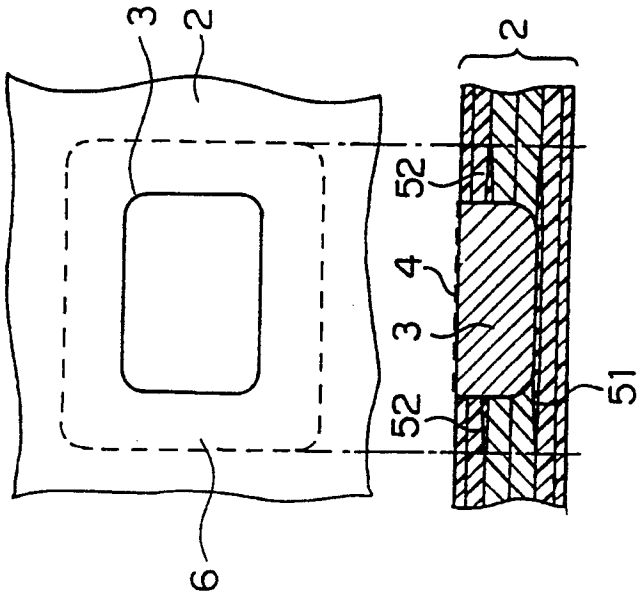


FIG. 2A

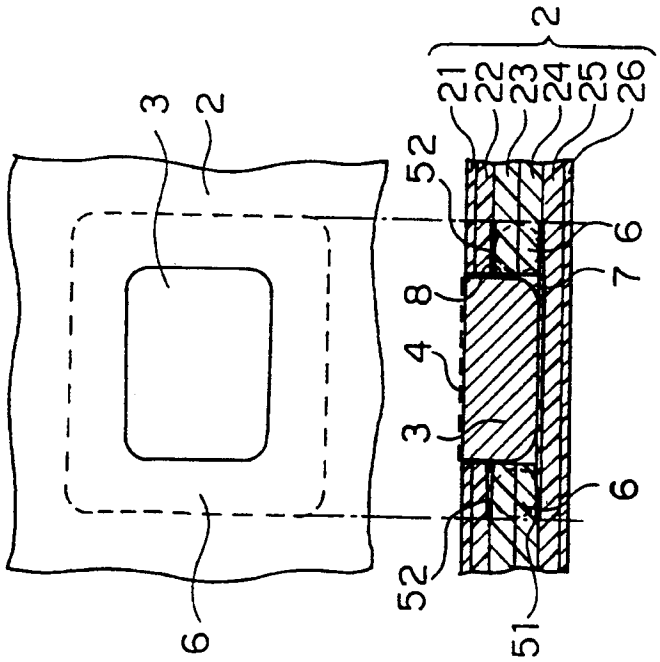


FIG. 3A

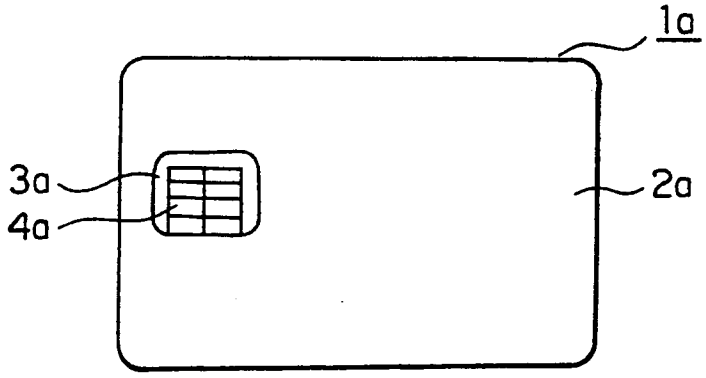


FIG. 3B

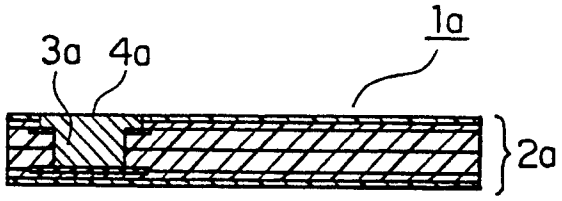


FIG. 3C

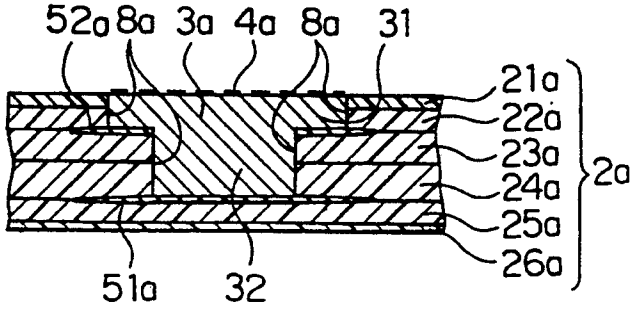


FIG. 4B

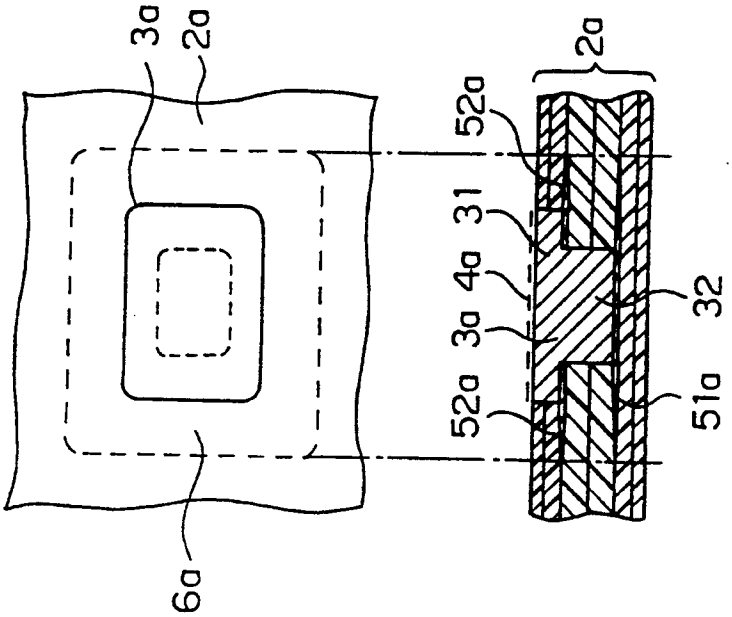

3a
2a
2a
52a
31
4a
3a
52a
32
51a
6a

FIG. 4A

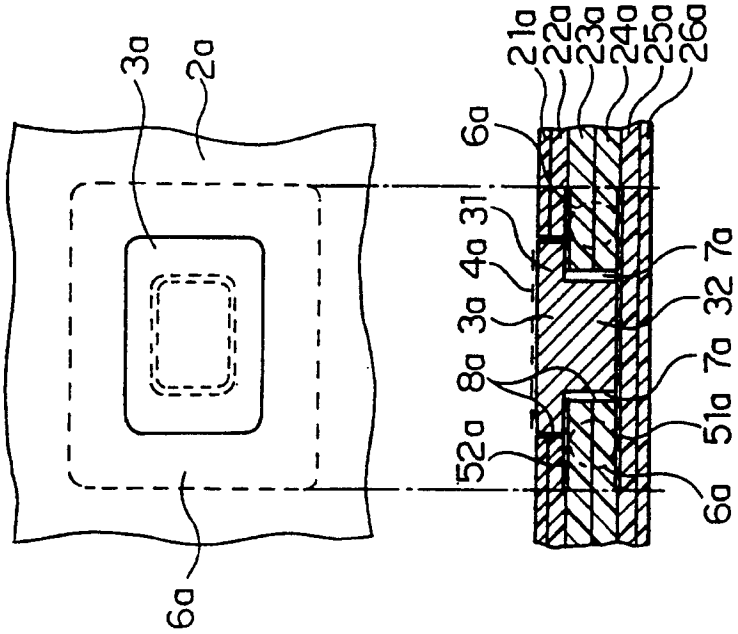

3a
2a
21a
22a
23a
24a
25a
26a
6a
31
4a
3a
8a
52a
7a
32
7a
51a
6a
6a

FIG. 5A

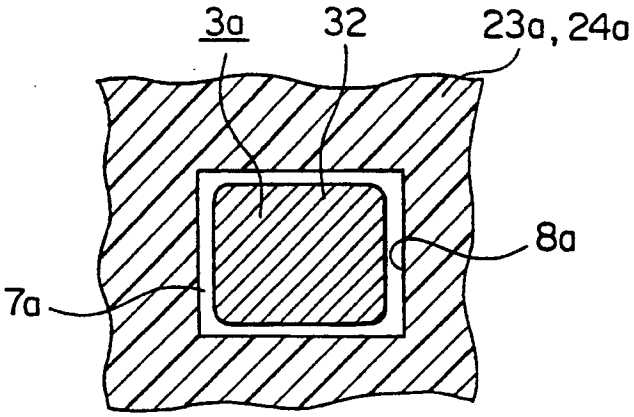


FIG. 5B

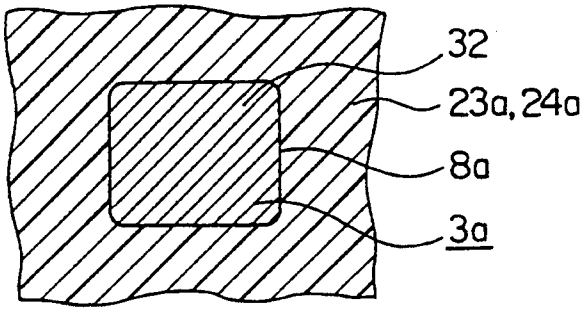


FIG. 6

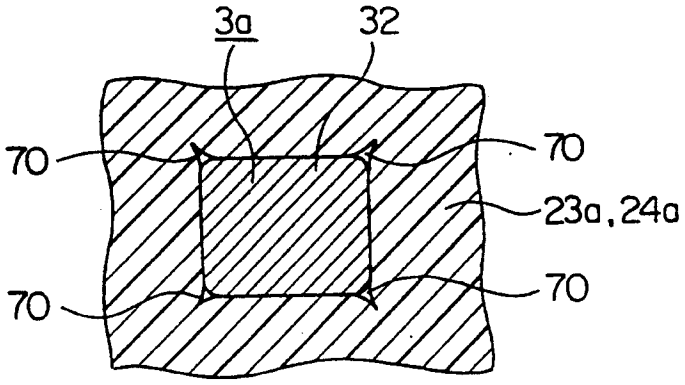


FIG. 7

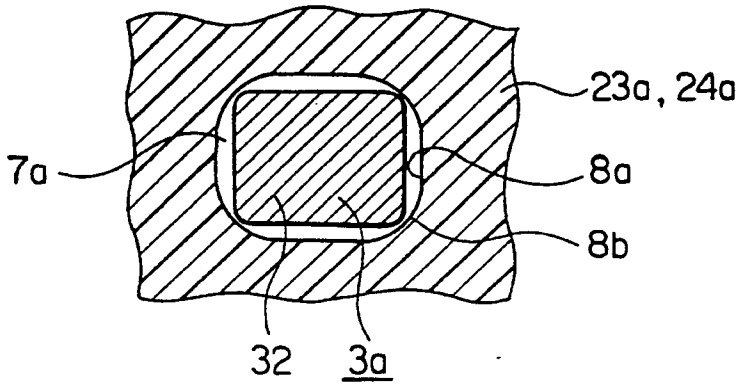


FIG. 8

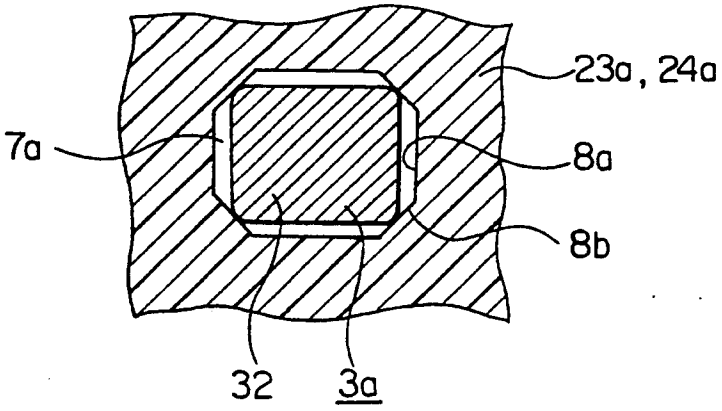


FIG. 9A
PRIOR ART

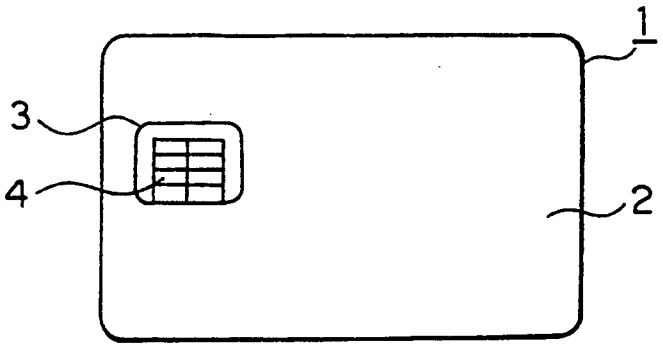


FIG. 9B
PRIOR ART

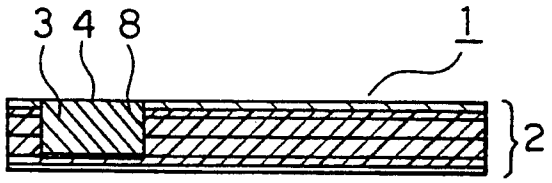


FIG. 9C
PRIOR ART

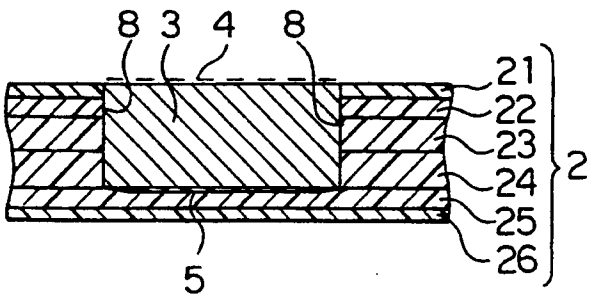


FIG. 10A
PRIOR ART

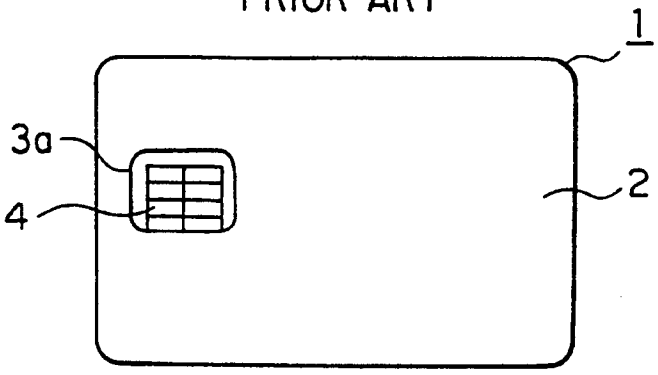


FIG. 10B
PRIOR ART

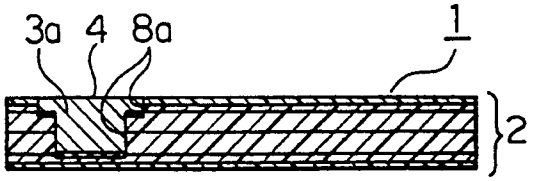
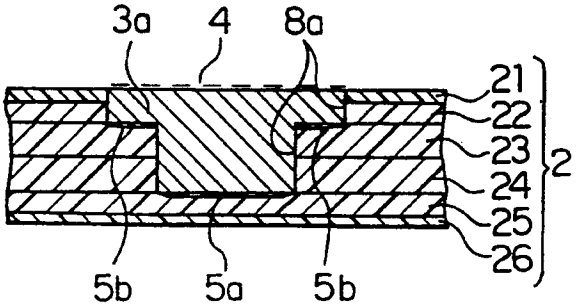


FIG. 10C
PRIOR ART



IC CARD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to the structure of an IC card and a manufacturing method therefore, the IC card being manufactured by integrally molding a multilayer structure and an IC module.

Hitherto, when an IC card of a type which is constituted by an IC module in an opening portion in a card substrate and a boundary portion adhered by an adhesive is manufactured, the adhesive is used only in the opening portion as described below.

FIGS. **9A** to **9C** illustrate an IC card of the type described above. FIG. **9A** is a plan view of the IC card. FIG. **9B** is a side cross sectional view of the same and FIG. **9C** is an enlarged cross sectional view which illustrates a card substrate **2** of an IC card **1** and IC module **3**. Referring to the drawings, the card substrate **2** is a multilayer sheet structure constituted by stacking overlays **21** and **26** as the outer layers which hold core sheets **22**, **23**, **24** and **25** therebetween. Each of the above-described sheets which form the multilayer structure has a through hole formed in a portion thereof forming an opening portion **8**. Furthermore, an adhesive layer **5** is formed on the core sheet **25** which serves as the bottom portion of the opening portion **8**, the adhesive layer **5** being disposed on the portion of the core sheet **25** which is in contact with the module **3**.

Then, a process for manufacturing the IC card will be described. First, all of the sheets **21** to **26** are stacked up so that the opening portion **8** into which the IC module **3** is placed is formed. After the IC module **3** has been fitted within the above-described opening portion **8**, the overall body is heated and pressure is applied while the body is held by a mirror plate. That is, the card substrate of an existing credit card is, as regulated in JIS X6301, structured in such a manner that a multiplicity of hard vinyl chloride sheets are layered, the sheets in the form of a multilayer structure being then heated and pressed so as to be integrally molded, i.e., welded to one another.

FIGS. **10A** to **10C** illustrate another IC card. An IC module **3***a* is arranged to have, in vertical cross section a stepped portion. As shown in FIG. **10C** which is an enlarged cross sectional view, an opening portion **8***a* into which the IC module **3***a* is fitted also has a two-step cross sectional shape and the adhesive layer is divided into two layers (**5***a* and **5***b*). Other structures and the process for stacking the sheets and integrally molding the stacked structure are the same as those of the structure shown in FIGS. **9A** to **9C**.

The conventional IC cards of the type described above have been arranged in such a manner that the IC module is fitted within the opening portion formed through the sheets which constitute the card substrate. Therefore, the contour of the IC module and that of the opening portion must have precise dimensional accuracy. In particular, there arises a problem in that the IC module **3***a* having, as illustrated in FIGS. **10A** to **10C**, shape cannot easily be fitted into the opening portion **8***a* formed in the multilayer sheet while maintaining precise accuracy.

SUMMARY OF THE INVENTION

An object of the present invention is to overcome the above-described problems. Therefore, an object of the present invention is to provide an IC card and a manufacturing method therefore capable of, at the time of an integral molding with heat and pressure, perfectly plugging a gap generated due to variations in the dimension accuracy of an opening portion formed in a card substrate and that of the contour of an IC module which is coupled with the opening portion.

An IC card according to the present invention comprises: a card substrate having a multilayer sheet structure formed by stacking a plurality of sheets, the multilayer sheet structure having an opening in which an IC module is mounted; and an adhesive for adhering the IC module to the card substrate, the above-described card substrate, the multilayer sheet structure, the IC module and the adhesive being integrally molded with heat and pressure, wherein the adhesive is applied to a portion around the IC module between internal layers of a multilayer sheet constituting the card substrate in such a manner that two or more adhesive layers are at least partially overlapped so as to be integrally molded with heat and pressure.

According to the present invention, the adhesive placed between the internal layers of the multilayer sheet structure is melted at the time of the integral molding with heat and pressure. Therefore, the sheet material held between the adhesive layers can easily be deformed due to the action of the adhesive serving as a lubricant. As a result, a gap formed around the opening portion into which the IC module is mounted can be filled.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1A** to **1C** are respectively a plan view, a side cross sectional view and an enlarged cross sectional view which illustrate an embodiment of an IC card according to the present invention;

FIGS. **2A** and **2B** are partially enlarged views which respectively illustrate a state before of the IC card shown in FIGS. **1A** to **1C** and a state after the IC card has been integrally molded;

FIGS. **3A** to **3C** are respectively a plan view, a side cross sectional view and an enlarged cross sectional view which illustrate another embodiment of an IC card according to the present invention;

FIGS. **4A** and **4B** are partially enlarged views which respectively illustrate a state before of the IC card shown in FIGS. **3A** to **3C** and a state after the IC card has been integrally molded;

FIGS. **5A**, **5B** and **6** are plan cross sectional views which illustrate a state where a gap between an IC module and an opening portion are is filled;

FIG. **7** is a plan cross sectional view which illustrates the shape of a through hole formed in a core sheet of the IC card according to the present invention;

FIG. **8** is a horizontal cross sectional view which illustrates the shape of a through hole formed in a core sheet of the IC card according to another embodiment of the present invention;

FIGS. **9A** to **9C** are respectively a plan view, a side cross sectional view and an enlarged cross sectional view which illustrate a conventional IC card; and

FIGS. **10A** to **10C** are respectively a plan view, a side cross sectional view and an enlarged cross sectional view which illustrate another conventional IC card.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will now be described with reference to the drawings.

FIGS. 1A to 1C illustrate an IC card according to the present invention. FIG. 1A is a plan view which illustrates the IC card, FIG. 1B is a side cross sectional view which illustrates the same and FIG. 1C is an enlarged cross sectional view which illustrates a state where a card substrate 2 and an IC module 3 are combined. FIG. 2A is an enlarged view which illustrates a state before the card substrate 2 of the IC card 1 and the IC module 3 are integrally molded. FIG. 2B is an enlarged view which illustrates a state after they have been integrally molded.

Referring to the drawings, the card substrate 2 is, similarly to the conventional structure, in the form of a multilayer sheet structure arranged in such a manner that overlays 21 and 26 serving as the outer layers and core sheets 22, 23, 24 and 25 serving as the inner layers and held between the overlays 21 and 26 are stacked. Furthermore, an opening portion 8 into which the IC module 3 is fitted is formed in the above-described multilayer structure.

According to this embodiment, an adhesive is applied in such a manner that two layers of adhesive are respectively disposed between the core sheets 22 and 23 and between the core sheets 24 and 25, the adhesive being placed only around the opening portion 8. That is, as shown in FIG. 2A, an adhesive 52 is placed between the core sheets 22 and 23. Furthermore, an adhesive 51 is placed between the core sheets 24 and 25, including a portion which comes in contact with the bottom surface of the IC module 3. Furthermore, the adhesives 51 and 52 are applied so as to form layers around the opening portion 8 formed in the card substrate into which the IC module 3 is fitted. In this state, the IC module 3 is fitted into the opening portion 8 in such a manner that its external connection terminal 4 appears outside the surface of the IC card.

At this time, a gap 7 is formed between the opening portion 8 in the card substrate 2 and the IC module 3. In particular, since the opening portion 8 positioned in the card substrate is formed by overlapping the through holes formed in the core sheets, the shape of the opening portion 8 usually becomes a rectangular shape. Therefore, the gap 7 becomes too large as shown in FIG. 2A when the IC module, which has rounded corners along its bottom side which opposes the external connection terminal 4, is mounted.

After the sheets 21 to 26, the adhesives 51 and 52 and the IC module 3 have been coupled to one another, heat and pressure are applied to the coupled structure while holding the two sides of the structure (omitted from the illustration) so that a stacked structure is molded.

If the adhesive 5 (see FIGS. 9C and 10C) is softened or melted at the time of molding the stacked structure, the gap cannot be filled satisfactorily since there is no passage through which the adhesive 5 may flow. In particular, a relatively large gap 7 as shown in FIG. 2A cannot be filled. As a result, the gap causes undesired wrinkles on the card surface, which critically damages appearance of the IC card.

However, according to this embodiment, the adhesives 51 and 52 are applied so as to form the two overlapped layers. Therefore, a portion 86 around the opening portion formed in the core sheets 23 and 24, which are held by the adhesives 51 and 52, of the card substrate is held with slide surfaces at the time of molding the stacked structure by heat and pressure. As a result, the portion 6 can move sideways very easily, causing the gap 7 to be plugged filled, as shown in FIG. 2B, by the core sheets 23 and 24 which can slide.

Furthermore, as shown in the drawings in detail, since the adhesives 51 and 52 are simply held between the core sheets, the area that each of the portions to which the adhesives 51 and 52 have been respectively applied is enlarged by the amount of the adhesives 51 and 52 before the integral molding is performed. However, since the gap is filled by the core sheet after integral molding with heat and pressure, the surface can be flattened. The portion of the IC card to which no adhesive is applied does not, of course, slide sideways during molding of the stacked structure.

The sheets (made of, for example, vinyl chloride resin) of the card substrate are respectively melted at temperatures near their melting points at the time of molding the stacked structure (by heat and pressure). Therefore, for example, a heat sensitive adhesive having a melting point which is lower than that of the material (vinyl chloride) of the sheet is employed as the adhesives 51 and 52. As an alternative, a pressure sensitive adhesive or a B-stage heat sensitive type adhesive may be employed.

An essential portion of this embodiment lies in that two adhesive layers serving as lubricating layers at the time of molding the stacked structure to form the IC card are stacked so as to easily move and deform the core sheets disposed between the adhesive layers. As a result, the gap around the IC module can be eliminated.

FIGS. 3A, 3C, 4A and 4B illustrate another embodiment of the IC card according to the present invention. FIG. 3A is a plan view which illustrates the IC card, FIG. 3B is a side cross sectional view which illustrates the same and FIG. 3C is an enlarged cross sectional view which illustrates a state where a card substrate 2*a* of an IC card 1*a* and an IC module 3*a* are coupled to each other. FIG. 4A is an enlarged view which illustrates a state before the card substrate 2*a* of the IC card 1*a* and the IC module 3*a* are coupled to each other. FIG. 4B is an enlarged view which illustrates a state after they have been coupled to each other.

According to this embodiment, the vertical cross sectional shape of the IC module 3*a* is not a rectangle but is a two-stepped shape arranged in such a manner that the side on which the external connection terminal 4*a* is present has a larger area on the surface of the card than within the card. When the IC card is warped, stress is concentrated in a portion of the card substrate with which the lower corner of the IC module comes in contact. Therefore, the above-described portion can easily be broken. Accordingly, the shape of the IC module 3*a* according to this embodiment is arranged as illustrated so that the number of the corners of the IC module 3*a* is increased so as to disperse the stress applied when the IC card is warped. In the following description, the portion of the IC module 3*a* having a large horizontal area is called a "terminal mount portion 31" and the portion having a small area is called a "body portion 32".

In this case, an opening portion 8*a* formed in a card substrate 2*a* is formed by stacking sheets respectively having through holes the size of which are different from one another. Therefore, an error may occur in the stacked sheets. Furthermore, the IC module 3*a*, when it

is manufactured, may vary in its shape between the terminal mount portion **31** and the central axis (the vertical axis) of the body portion **32**. The external connection terminal **4***a* must be positioned at a desired position on the card substrate **2***a* so as to establish a satisfactory connection with the card reader of the IC card. Therefore, the distance between the terminal mount portion **31** of the IC module **3***a* and an overlay **21***a* and that between the IC module **3***a* and a core sheet **22***a* must be greatly reduced. Therefore, both the above-described dimensional deflections are absorbed by the body portion **32** of the IC module **3***a*. That is, the through holes respectively formed in the core sheets **23***a* and **24***a* have a large size, whereby a large gap **7***a* is formed.

When the stacked structure is integrally molded with heat and pressure, the portion **6***a* of the intermediate layer surrounding the IC module **3***a* held between the adhesive layers **51***a* and **52***a* slides inwards due to the lubricating action of the adhesive layer **52***a* between the core sheets **22***a* and **23***a* and the adhesive layer **51***a* between the core sheets **24***a* and **25***a*. As a result, the above-described gap **7***a* can effectively be filled.

FIG. **5**A is a plan cross sectional view which illustrates a portion of the core sheets **23***a* and **24***a* held between the adhesive layers **51***a* and **52***a* according to the second embodiment shown in FIGS. **3**A to **4**B, i.e. the portion surrounding the IC module **3***a*. As described above, the through hole formed by the core sheets **23***a* and **24***a* held between the adhesive layers **51***a* and **52***a* is large enough to absorb the dimensional tolerance of the opening portion **8***a* and the IC module **3***a*. The gap **7***a* exists around the IC module **3***a* before the integral molding. In the case shown in FIG. **5**A, the through hole **8***a* formed by the core sheets **23***a* and **24***a* is substantially similar to the body **32** of the IC module **3***a*. Furthermore, the width of the gap **7***a* is substantially constant around the IC module **3***a*. After the integral molding has been completed with heat and pressure, the gap **7***a* is filled due to the deformation of each of the core sheets **23***a* and **24***a*. Identically, the gap **7***a* may be completely filled by the core sheet material as shown in FIG. **5**B.

However, portions **70** which are not filled with the core sheet material will, as shown in FIG. **6**, be formed at positions which correspond to the four corners of the IC module **3***a*. The above-described undesirable portions **70** will be formed in a case where deformation of the core sheets **23***a* and **24***a* around the IC module **3***a* takes place parallel to the gap **7***a* and the deformation at the central portion of each of the four sides, which is the straight portion, takes place faster than the deformation of the four corners. If the portions **70** which are not filled with the core sheet material are formed, undesirable recessed portions or pits may be formed along the surface of the IC card.

Accordingly, another embodiment of the present invention is, as shown in FIG. **7**, arranged in such a manner that the through hole **8***a* formed in the core sheets **23***a* and **24***a* is in the form of a shape having four corner portions **8***b* which respectively have a radius of curvature which is larger than that of the corner of the body portion **32** of the IC module **3***a*. As a result, if the speed of deformation of the straight portion of the through hole **8***a* is too fast, the gap **70** (see FIG. **6**) can be completely eliminated from each of the corner portions **8***b*. The elimination of the undesirable gap is a critical factor in improving the appearance of the IC card. If a slight portion which is not filled with the core sheet material exists, undesirable pits are formed in the surface of the IC card, causing the quality of the appearance of the IC card to be deteriorated. Furthermore, even if the dimension of the body portion **32** of the IC module **3***a* and that of the through hole **8***a* vary, the above-described two elements are in point-contact. Therefore, the IC module **3***a* can smoothly be fitted within the opening portion.

The through hole **8***a* formed in the core sheets **23***a* and **24***a* may be in the form of a shape formed by cutting straight the corner portion **8***b* diagonally as shown in FIG. **8**. The shape of the through hole formed in the core sheets **23***a* and **24***a* is not limited to the shapes respectively shown in FIGS. **7** and **8**. Any shape can be employed if it is arranged in such a manner that the width of the gap **7***a* is reduced in the corner portion or the corner portion is able to contact the corner portion of the IC module in a point-contact.

According to each of the above-described embodiments, two layers composed of the core sheets **23** and **24** (**23***a* and **24***a*) are placed between the adhesive layers **51***a* and **52***a*. However, a similar effect can be obtained from a structure in which one core sheet is placed between the adhesive layers or a structure in which three or more core sheets are stacked.

Another structure may be employed which is arranged in such a manner that three or more adhesive layers are stacked by additionally providing an adhesive layer between the core sheets **23** and **24** (**23***a* and **24***a*).

As described above, the IC card according to the present invention is arranged in such a manner that the adhesive is applied to form two or more layers which overlap one another around the opening portion into which the IC module is embedded, the adhesive being placed on the inner surface of the card substrate having the multilayer sheet structure. Therefore, the core sheet layer held between the adhesive layers can easily be deformed at the time of integral molding with heat and pressure. As a result, the gap between the card substrate and the IC module can be perfectly filled. Furthermore, the above-described opening portion formed in the core sheets held between the adhesive layers is arranged in such a manner that the gap with the IC module is reduced in the corners of the opening in comparison to the gap along the straight sides of the module. As an alternative to this, the opening portion is arranged to come in contact with the corner portion of the IC module at a point-contact. Therefore, the gap can be eliminated from the corner portion of the IC module after the integral molding has been performed. As a result, the gap around the IC module can be perfectly and assuredly filled.

What is claimed is:

1. An IC card comprising:

an IC module having opposing first and second surfaces, a relatively large cross sectional area in a first portion and a relatively small cross sectional area in a second portion and including an external connection terminal on the first surface;

a card substrate including a stack of a plurality of core sheets, a portion of said plurality of core sheets including through holes forming an opening receiving said IC module with the first surface exposed; and

a plurality of adhesive layers disposed between respective core sheets adjacent said IC module, wherein at least two of said adhesive layers are

disposed directly opposite each other adjacent said IC module within said stack of core sheets.

2. An IC card according to claim 1 wherein said IC module is substantially cubic, said first portion has a rectangular shape, said second portion includes rounded corners, and said at least two adhesive layers are placed between respective pairs of core sheets to respectively hold core sheets having through holes corresponding to said second portion of said IC module.

3. An IC card according to claim 2 wherein one of said adhesive layers is positioned in the opening in contact with the second surface of said IC module.

4. An IC card according to claim 1 wherein said IC module is in the form of a two stepped dice-like shape composed of an upper portion consisting of a terminal mount portion having an external connection terminal on the upper surface thereof and a large horizontal cross sectional area and a lower portion consisting of a body portion having a horizontal cross sectional area which is smaller than that of said upper portion.

5. An IC card according to claim 4 wherein said two or more adhesive layers are placed between said core sheets so as to respectively hold one or more core sheets positioned to correspond to said body portion of said IC module.

6. An IC card according to claim 1 wherein the through hole formed in a core sheet corresponding to said first portion of said IC module has a size and shape which does not form a gap with said IC module and the through hole formed in a core sheet corresponding to said second portion of said IC module has a size and shape to form a gap with said IC module.

7. An IC card according to claim 6 wherein one of said adhesive layers is positioned in the opening in contact with the second surface of said IC module.

8. An IC card according to claim 2 wherein each of the through holes formed in said core sheets has a shape forming a gap with said IC module which at least narrows at corner portions of said IC module.

9. An IC card according to claim 8 wherein each of said through holes formed in said core sheets positioned to correspond to said second portion of said IC module has, in the portion corresponding to said corners of said IC module, a shape rounded with a radius of curvature larger than the radius of curvature of said corners of said IC module.

10. An IC card according to claim 7 wherein each of the through holes formed in said core sheets has an octagonal shape including sides tangent to each of the corners of said IC module.

11. An IC card according to claim 1 wherein said card substrate includes an outer protection sheet layer formed by integral molding.

12. An IC card according to claim 1 wherein said adhesive layer is made of a heat sensitive type adhesive having a melting point lower than the melting point of said core sheets.

13. An IC card according to claim 1 wherein said adhesive layer is a pressure sensitive type adhesive.

14. An IC card according to claim 1 wherein said adhesive layer is a B-stage heat hardening type adhesive.

15. An IC card comprising:

an IC module having opposed first and second surfaces and including an external connection terminal on the first surface;

a card substrate including a stack of a plurality of core sheets, a portion of said plurality of core sheets including through holes forming an opening receiving said IC module with the first surface exposed; and

a plurality of adhesive layers disposed between respective core sheets adjacent said IC module, wherein at least two of said adhesive layers are disposed directly opposite each other adjacent said IC module within said stack of core sheets.

16. An IC card according to claim 15 wherein one of said adhesive layers is positioned in the opening in contact with the second surface of said IC module.

* * * * *

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United States Patent [19]

Laute et al.

[11] Patent Number: 5,268,699

[45] Date of Patent: Dec. 7, 1993

[54] **DATA COMMUNICATION RECEIVER UTILIZING A LOOP ANTENNA HAVING A HINGED CONNECTION**

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[73] Assignee: **Motorola, Inc.**, Schaumburg, Ill.

[21] Appl. No.: **949,950**

[22] Filed: **Sep. 24, 1992**

[51] **Int. Cl.**[5] **H01Q 1/24**; H04B 1/08

[52] **U.S. Cl.** **343/702**; 343/873; 455/351

[58] **Field of Search** ..... 343/702, 700 MS, 873, 343/741; 455/90, 89, 347, 351

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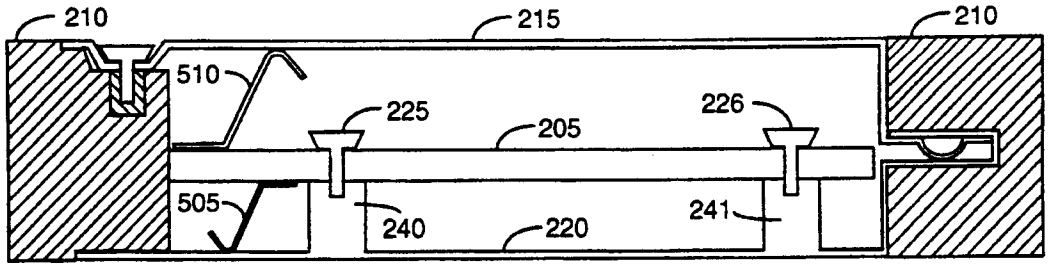
Assistant Examiner—Hoanganh Le
Attorney, Agent, or Firm—Kelly A. Gardner; Daniel R. Collopy; Thomas G. Berry

[57] **ABSTRACT**

A substantially card shaped data communication receiver (**100**) for receiving radio frequency (RF) signals comprises receiver circuitry for recovering information included in the RF signals, an insulative frame (**210**), a first conductive panel (**215**) disposed over a first side of the frame (**210**), and a second conductive panel (**220**) disposed over a second side of the frame (**210**) such that the receiver circuitry is enclosed within the space defined by the frame (**210**) and the first and second panels (**215, 220**). The first and second panels (**215, 220**) have coupling members formed thereon for electrically coupling the first panel (**215**) to the second panel (**220**). The data communication receiver (**100**) further comprises a first conductor (**510**) for electrically coupling the first panel (**215**) and the receiver circuitry and a second conductor (**505**) for electrically coupling the second panel (**220**) to the receiver circuitry such that the first and second panels (**215, 220**) function as an RF antenna when disposed over the first and second sides, respectively, of the frame (**210**).

9 Claims, 2 Drawing Sheets



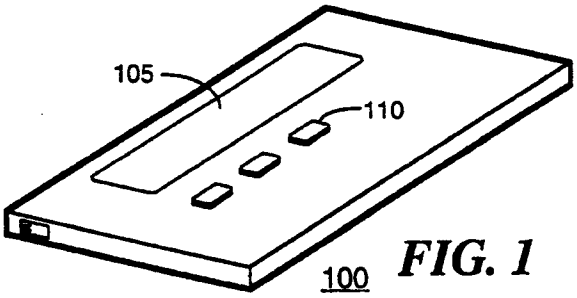


FIG. 1

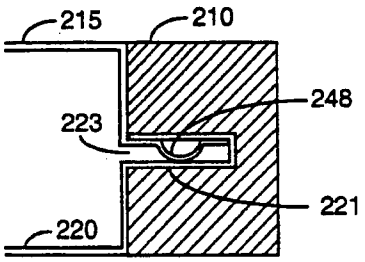


FIG. 3

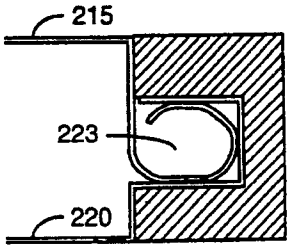


FIG. 4

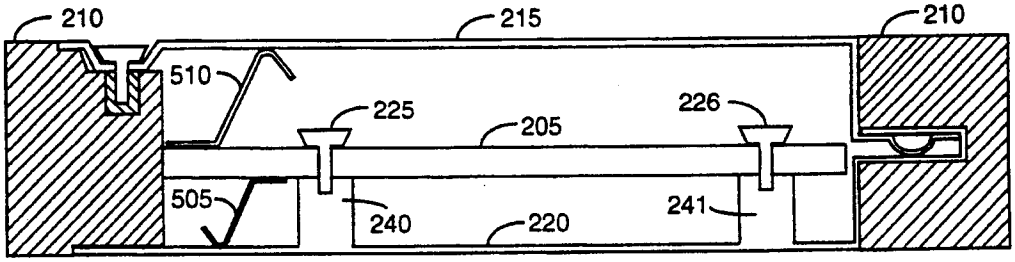


FIG. 5

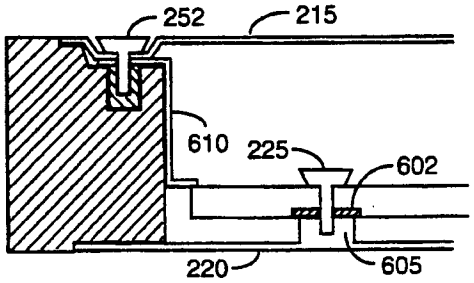


FIG. 6

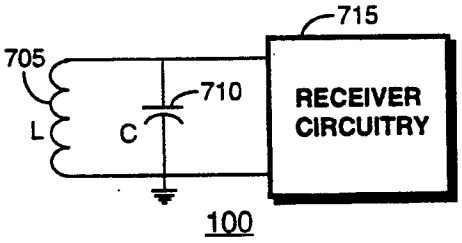


FIG. 7

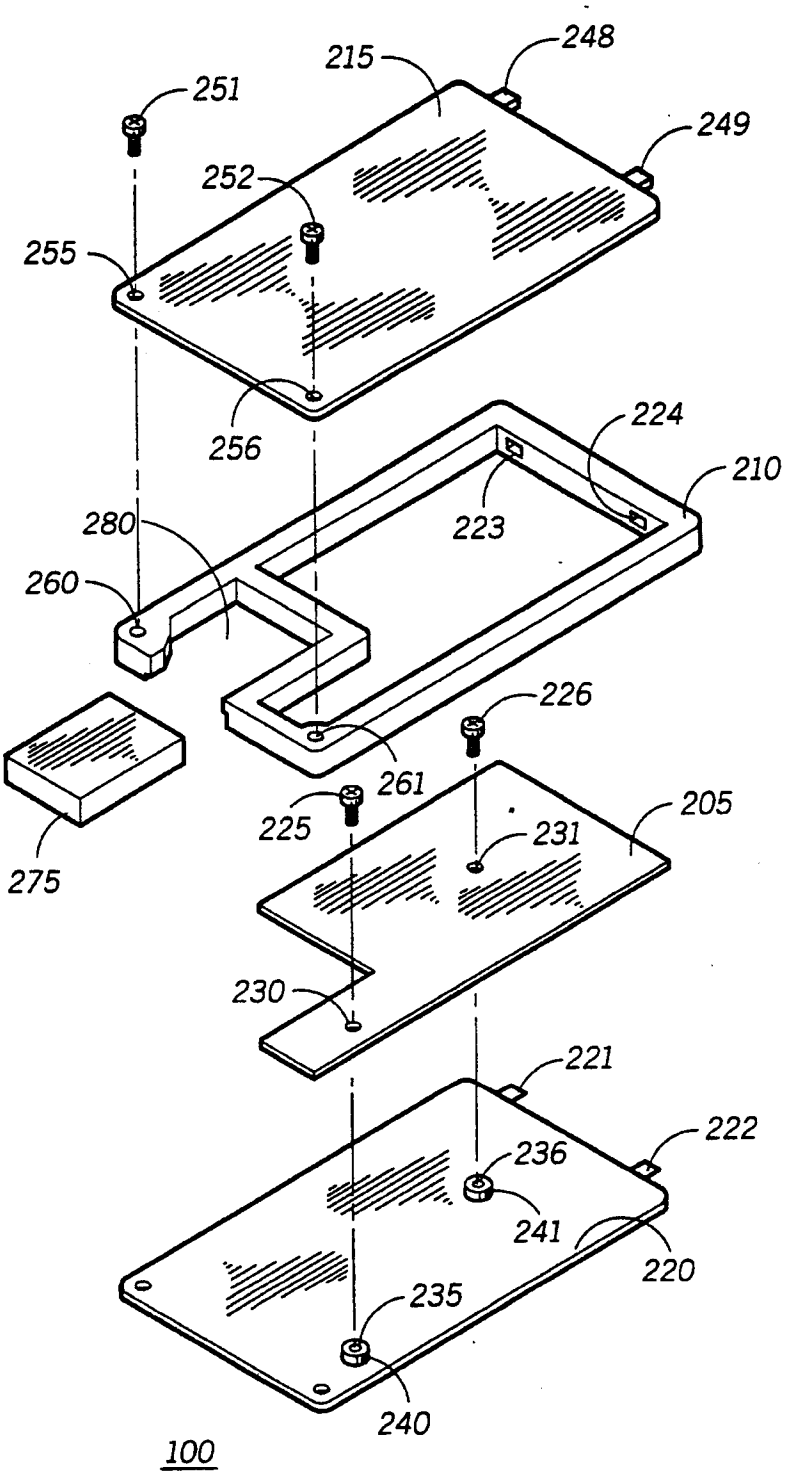

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FIG.2